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APR 10 1922

Popular Science

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Popular Science Monthly

Fiftieth Anniversary Number

May, 1922; Vol. 100, No. 5
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Look Fifty Years Ahead with Edison

World's Greatest Inventor Talks on Radio and Science for POPULAR SCIENCE MONTHLY'S *Fiftieth Anniversary*

WHAT is the future of the radiotelephone? What are likely to be the great scientific miracles of the coming half century?

Read what the most famous inventor of the past half century has to say.

Popular Science Monthly—celebrating this month the fiftieth year of its march, step by step, with the marvelous progress of science—asked Thomas A. Edison, the most famous of all inventors—the man who knew E. L. Youmans, founder of Popular Science Monthly, and who says he treasures in his library the bound volumes of the magazine—to comment on the 50-year period of science that has just passed, and on the possibilities of the greater era to come. What he has to say will interest every reader.

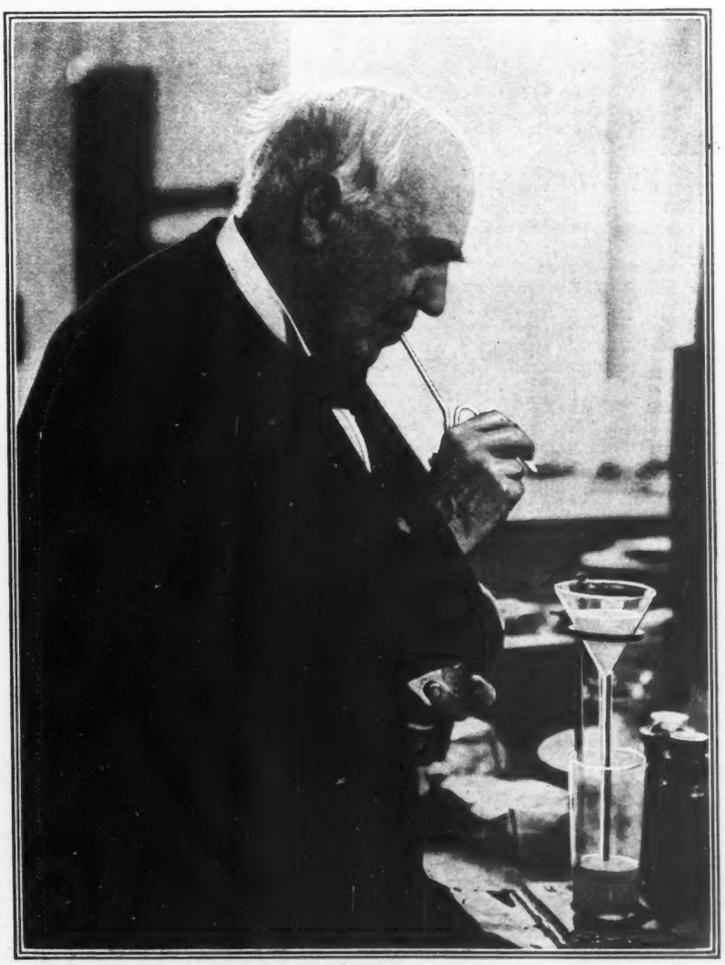
Scattered through this anniversary issue are five little romances of other famous inventors of the half century. Reading the fascinating stories of their careers, you will enjoy a more refreshing glimpse back over typical inventive achievements than if we had attempted to fill this entire magazine with reviews of the progress of science.

WHAT is the greatest project ever conceived for America's future prosperity?

Thomas A. Edison, in an interview for POPULAR SCIENCE MONTHLY, on the occasion of the magazine's fiftieth anniversary, gave the credit for it to Henry Ford, and said that the idea itself lay in Ford's proposal to establish all over the country numberless little industrial centers, wherever a stream furnishes water power.

"In these semirural industrial regions, made possible by the great scientific achievements of the 50-year period you are now celebrating," Mr. Edison explained, "the men who work our farms in the summer will go into the shops during the other months and so remain producers, in season and out. They will earn money the year round for the education of their children and the upkeep of their homes, while contributing more than ever to the national wealth."

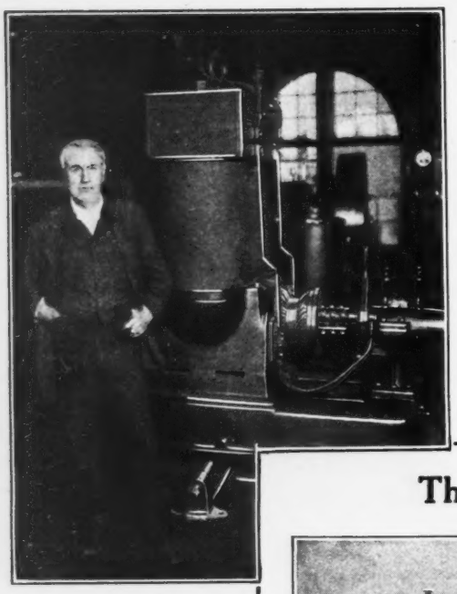
It was only the other day that Mr. Edison celebrated his seventy-fifth birthday, amid a shower of tributes and congratulations from all over the world.



Thomas A. Edison as he looks today. At the age of 75 he still works occasionally 24 hours on end in his laboratory

To-day POPULAR SCIENCE MONTHLY is celebrating its fiftieth birthday, marking a period of service in the cause of popular science to within three years since Thomas A. Edison secured his first patent. This half century that has just closed has been history's greatest era of invention, and Mr. Edison himself tops the list of its most famous inventors. It was, then, to the outstanding figure of the world's most brilliant period of scientific progress that POPULAR SCIENCE MONTHLY turned for comments on the achievements of science during its own lifetime, and on possible new triumphs to come.

"Expect just as startling advances in the next 50 years as you have seen in the past," said Mr. Edison. "And when you stop to think how different the world today has been made from that of 1872 by the inventions of the last half century, you will realize more vividly what the year 1972 may see in communication, transportation, and living conditions. Each of the achievements of the past 50 years—inventions such as the telephone, automobile, motion-pictures, the electric light — has



Edison as he appears today in his West Orange, N. J., plant, standing before his dynamo that lit the first electric lights

helped to bring greater pleasure, convenience, or education to us all. It is bosh to say that they have made us luxury-loving or materialistic. Civilization, after the past 50 years of phenomenal progress in invention, is on the right track and will continue to make more rapid strides along it.

"There is no limit, for instance, to the possibilities of the radiophone's development. The most minute sounds, thanks to amplifying devices, may be made audible across the continent. A fly's footsteps may be heard, or the dropping of a pin in New York may be heard in San Francisco. Imagination can hardly compass the practical possibilities of these developments. They mean the spread of information and entertainment on a hitherto unparalleled scale, drawing nearly every home in the land into the radiophone's educational influence.

"I believe that the government should strictly license and control all who are engaged in broadcasting; but we should leave as much of the field as possible open to amateurs.

"I approve of Will Hays' project of developing the Post Office into a department of communications, with a complete system of broadcasting stations that will keep the government in constant vocal touch with the great majority of American homes.

"When it comes to the radio transmission of power, I must say I can't see it as a possibility near enough to talk about. And the same holds true about that other glowing promise that some prophets have been making with reference to new energy resources—the liberation of atomic energy. I can't see the way to that, yet. Nevertheless, some fellow may come along and do *it* tomorrow.

"Thus we may expect increasingly dramatic possibilities from the next few decades of science, because of the activities of numberless patiently plodding research workers in almost infinitely specialized fields, any one of whom may have startling surprises in store for us that may help to make over the entire framework of civilization.

"We may confidently expect that intensified aeronautical research will increase the safety and convenience of flying until present-day dreams of transcontinental travel in great air liners may be realized.

"The demand for new brains to push forward along these lines, to carry on the ever more complicated processes of research, invention and industry, will be so enormous as to warrant a greater proportion of young men going into science and engineering than ever before.

"To those of you who stand at the threshold of a scientific career, let us say, 'If you have real industry and ability, you are wanted at the top.' The good ones are so rare! I know only too well how badly they are wanted, and how few they are!

"As the basis of all preparation for success in science and invention, take up physics. Physics and chemistry stand right at the bottom of everything else. My son writes me from college that courses in physics are dodged like the plague by the very men who presumably are planning to enter scientific pursuits. But college is too late. Education must be intensified at earlier ages. Ninety per cent of our education should be attained between the ages of six and 14 years.

"Research men of ability must have imagination. Rarely do we see a man with this great power rightly developed. Between the ages of six and 14 a large percentage have strong imagination, but our system of education allows it to atrophy. After 14, if imaginative organs have atrophied, the boy is hopeless.

"When you attempt to look ahead into what the coming years may bring, don't forget that man himself hasn't changed for a thousand years. In our happier, more comfortable environment, we have the same old defects, the same old weaknesses. You mustn't ask me to predict any Utopias 50 years or 200 years hence. No doubt there is a small increment every year of better and nobler persons alive than in previous years. But the percentage is so small that it takes centuries to make any startling difference. The upward sweep is going on all

(*Concluded on page 106*)

The Napoleon of Invention

The Edison of yesterday with his machine for taking dictation

BY all odds the best customer the United States patent office ever had is Thomas Alva Edison. In 54 years Edison has taken out more than 900 patents. His score on January 1, 1903, was 791 patents, an average of more than one a fortnight for 30 years, costing him $51,000 in patent office fees. After that he showed more respect for the speed limit.

Edison started on a career of research and discovery when he was five years old. Told that hens set to hatch chickens, he undertook to save labor by sitting on an extra large nestful himself. Results were discouraging. Further research when he was a railroad peanut peddler set fire to the baggage car. The conductor gave him a blow that made him deaf for life.

His first patent, October 11, 1868, when he was just over 21, was for a vote recorder. It brought no money. After a few years as a wandering telegraph operator, renowned as a practical joker, he landed in New York City in 1870 at the age of 23, penniless. Getting a job with a company trying to operate a crude stock ticker, Edison made improvements that saved the business. A few months later he invented a stock ticker he thought might bring $5000. Not daring to ask so big a sum, he "stalled," until the president offered $40,000 and paid the money before Edison "came to."

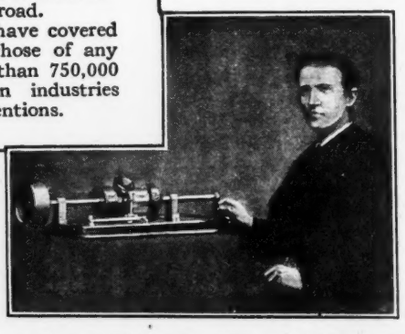
That vast sum started Edison on his career in a little shop in Newark, New Jersey. Soon he produced the quadruplex telegraph, which saved millions in line construction.

In 1876 Edison established a laboratory in Menlo Park, New Jersey, where with a staff of young enthusiasts he entered on a wild debauch of discovery and invention that made him world famous and his laboratory America's great show place. Often, in desperate pursuit of an idea, he would go 48 and even 72 hours without sleep, eating little.

One such spree produced the phonograph. Another led to the invention of the incandescent light, the first one of which was placed in circuit October 21, 1879, and burned for 40 hours.

Two years of steady plugging enabled Edison, at the age of 35, to complete and put in operation in 1882 the world's first life-sized experimental electric railroad.

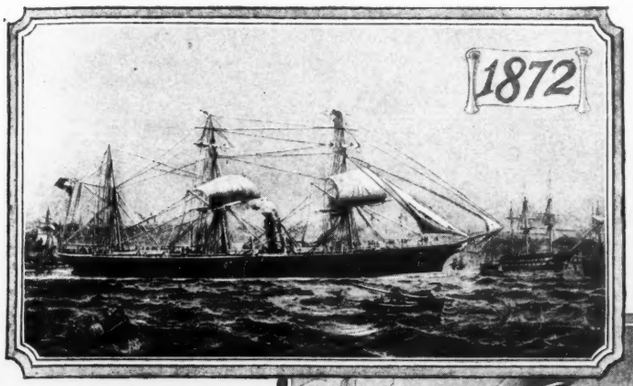
Edison's activities have covered a wider range than those of any other inventor. More than 750,000 men are employed in industries based on Edison's inventions.



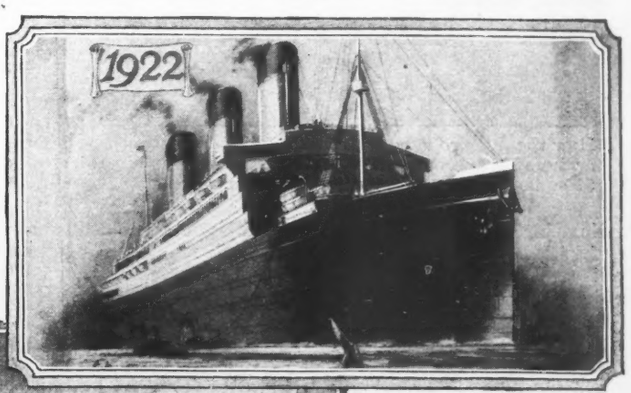
Young Edison in 1877, with the machine that first reproduced the human voice—a sheet of tinfoil on a cylinder turned by hand

Deep Sea Anchor to Revolutionize Ocean Travel

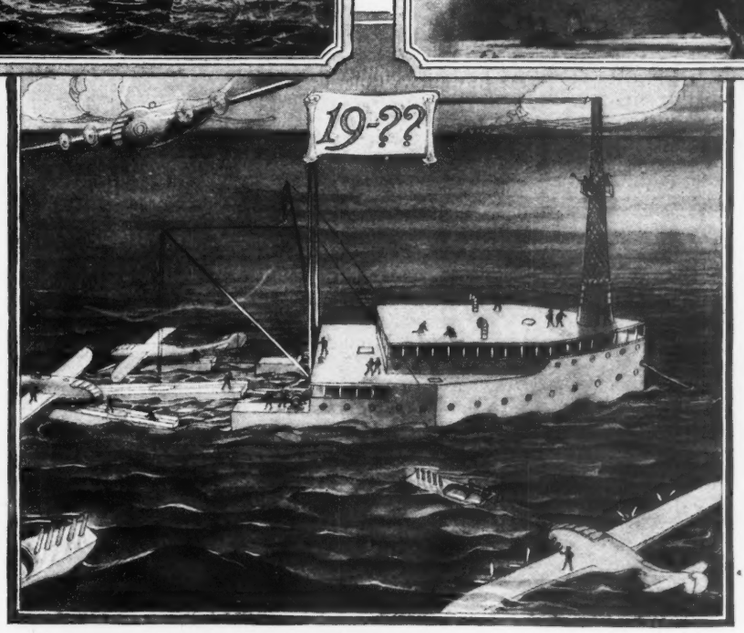
"Mother Ship" Way Stations, Secured Over "Unfathomable" Depths, Remove Obstacles to Transatlantic Airplane Service



Fifty years ago the liner, *Empress of Russia*, was the pride of the sea; yet she was less than one twentieth the size of the palatial new *Majestic*



The new 56,000-ton liner, *Majestic*, world's largest vessel, represents the limit in steamship magnitude, say experts, who see in the airliner the next step in ocean travel



Anchored to the ocean bottom, the proposed sea stations for transatlantic airplanes will be reliable landing fields, equipped with powerful radio apparatus, "trouble ships" to rescue disabled planes, floating platforms for seaplanes, meteorological instruments and comfortable quarters for travelers. They will carry crews of mechanics and pilots

By Wilfred S. Ogden

THE last serious obstacle in the way of transatlantic airplane passenger, express, and mail service appears to have been removed with the recent discovery of a practical method of securely anchoring ships to the ocean bottom in water three, four, and five miles deep.

With this discovery, making possible the first tangible plan of establishing floating way stations at 500-mile intervals along the ocean route, comes the announcement of a gigantic new American project for a transatlantic airplane system to provide transport at a cost no greater than the rates on first class liners and to reduce the time of the 3000-mile passage from New York to Plymouth, England, from an average of eight or nine days to from 24 to 36 hours.

The proposed method of deep-sea anchoring is the invention of E. R. Armstrong, a noted engineer of Wilmington, Del., who is a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. Heretofore a depth of about 200 feet was considered the practical limit for safe anchorage, because of the great weight of a sufficiently strong chain or cable, at least 600 feet long.

While studying the performances of the United States transcontinental air mail service, Mr. Armstrong became convinced that long-distance flying is practicable only in comparatively short jumps. The problem as applied to crossing the Atlantic resolved itself, consequently, into providing way stations at intervals easily spanned by craft of ordinary speed and with a fuel capacity sufficient to keep them aloft for five or six hours.

The total weight that can be carried by an airplane is equal to the weight of the machine plus the weight of the load it can transport under normal flight conditions. The load comprises the weight of fuel and crew, which are indispensable, and the weight of the pay load, which necessarily varies with the distance.

A 30,000-pound machine flying at 120 miles an hour would have a maximum range of flight of about 1300 miles if its useful load consisted entirely of fuel. For a distance of 1000 miles the fuel load would have to be 9500 pounds, leaving 2500 pounds for the pay load. At 500 miles the fuel load would not exceed 5000 pounds, and the airplane could therefore carry a pay load of 7000 pounds. Over a distance of 250 miles it would be able to carry a pay load of 9400 pounds. It has been calculated that by providing suitable landing stations on any flight course the pay load of an airplane can be made 80 per cent of its total useful load.

Considerations of this sort early showed Mr. Armstrong the need for an invention of the type he has now achieved. He turned his back on the attempts of most of his colleagues—to develop airplanes that would make the entire flight of 3000 miles from New York to London in a single jump—and devoted his efforts to providing the way stations needed to put the crossing within the easy flight range of any average airplane.

His invention provides means for deep-sea anchoring of station ships equipped with

The Airliner—New Queen of the Sea

PROBABLY the greatest transatlantic liner the world will ever see is on her maiden voyage this month. The monster, 56,000-ton *Majestic*, 956 feet long, a floating palace for 4000 passengers and crew, will probably never be surpassed in magnitude, shipping experts say.

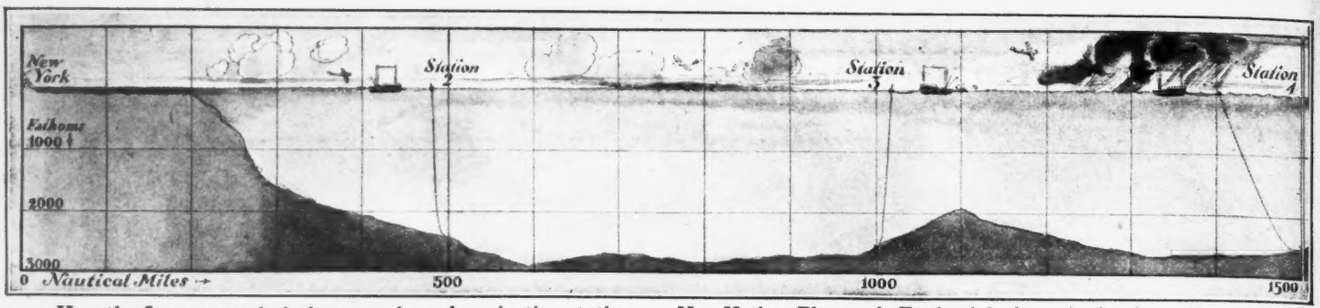
The *Majestic* represents the last chapter in the spectacular growth of ocean shipping in the 50 years of POPULAR SCIENCE MONTHLY'S career. One need only compare her with the liner, *Empress of Russia*, 358 feet long and accommodating 235 passengers—the pride of the sea 50 years ago—to realize the vast strides in sea travel during the half century.

On this page, pictures of the two vessels—each the greatest in its day—raise the question:

What will be the next step in transatlantic travel?

By all signs, the day of the airliner has dawned. Ocean airship transportation companies already are being formed, and the most feasible routes for freight and passenger traffic are being mapped.

The accompanying article describes a remarkable project for solving one of the most pressing problems in the way of successful air travel across the ocean.

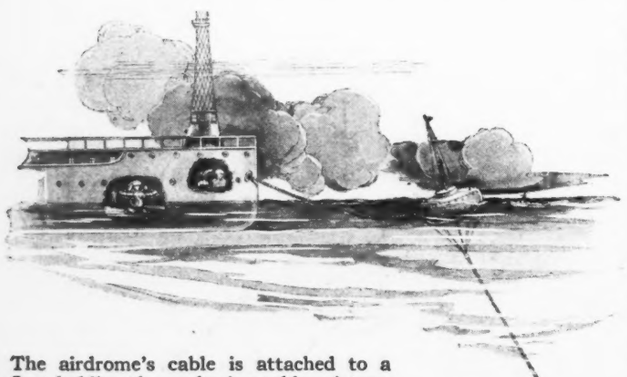


How the five proposed airplane supply and navigating stations, anchored in approximately three miles of water, will be located at 500-mile intervals along the southern steamship route from New York to Plymouth, England, is shown in the above diagram. Station 2 is a division point for planes leaving Norfolk, New York, Boston, and Halifax. Traffic from St. John's, Newfound-

landing platform, compensating automatically for the longitudinal pitch of the vessel, itself gyrostabilized to eliminate the roll incident to rough seas.

The idea of using ships at sea as landing places for airplanes is not new. "Mother ships" were successfully employed by the British during the war, while the United States Navy has built and is building airplane carriers equipped with platforms on which land airplanes may alight and from which they may take off with extreme facility.

The difficulty in working out such a project as Mr. Armstrong now suggests has been in the past the utter lack of feasible means for deep-sea anchoring. It has been recognized that unless vessels are securely fixed at the points selected, they cannot be available as supply stations, rescue bases, or as places of refuge in time of storm. If not anchored, even though provided with power, the whole series of stations would be widely scattered by a severe Atlantic storm of several days' duration.



The airdrome's cable is attached to a float holding the anchoring cable. A towing hawser from the float is fastened to an engine in the bow, which automatically takes up the slack

Anchor Is Attached to Float

The Armstrong method of anchoring, illustrated in the accompanying sketches (calculations based on operations in water three miles deep, the maximum encountered in a generally direct route from New York to Plymouth), departs from the customary method of linking the anchor directly to the vessel by means of a cable. This method is declared to be impracticable because the great weight of three miles of steel cable or chain would so seriously hamper the movements of the ship in response to wind and waves as to court almost certain disaster.

Instead, the inventor attaches his cable to an anchorage float, similar to the buoys used as channel markers, but so proportioned that its displacement is greater than all combined submerging forces to which it might be subjected. To this float is attached the anchoring cable of such weight, strength, and length that the lifting effect of the float, added to the maximum force of the anchored vessel pulling against it, is insufficient to raise all of the cable from the bottom.

To the float is attached a towing hawser, the other end of which is made fast to a towing engine in the bow of the vessel to be anchored. The engine would be designed to automatically take up the slack in the hawser, while the propelling equipment of the vessel proper would be employed, on the other hand, to relieve the strain on the line in severe storms. The float would be equipped with apparatus for discharging oil to calm waves in bad weather.

As an example, Mr. Armstrong, assuming a sea station or anchored vessel of approximately 1600 tons, arranges the anchorage and proportions the weights of anchor, cable, float, and sea stations as follows:

The anchor, of the mushroom type, weighs 5000 pounds and is attached to the cable by 1000 feet of steel chain cable, two inches in diameter and weighing 230 pounds a fathom.

To the chain cable are attached 5000 feet of galvanized steel cable 1½ inches in diameter; then 5000 feet of 1¾-inch steel cable; then 5000 feet of two-inch steel cable; and then the last, upper stretch of 5000 feet of 2¼-inch steel cable, secured to the float, the entire cable weighing about 75 tons.

The anchorage float is 36 feet in diameter and 15 feet deep, with a displacement of 380 tons, made of steel plating and provided with a signal mast. It is equipped with a shackle to which is attached the end of the 1¾-inch galvanized steel deep-sea towing hawser, 1200 feet long; the other end of the hawser being connected with the winding drum of the automatic steam towing machine in the bow of the sea station.

Under abnormal climatic conditions the entire apparatus is designed to respond to the drifting force of the wind and waves merely by lifting a greater or lesser part of the anchoring cable from the bottom of the ocean, while maintaining a balance of all the component forces. The anchored vessel has a drifting radius of more than two miles, including that allowed by the inclination from the perpendicular of the anchoring cable and the horizontal reach of the towing hawser.

How Anchor Is Held Fast

Assuming that the drift of the float and sea station has been 2¼ miles from the line perpendicular to the position of the anchor, and assuming a backward drifting force by the sea station of 30,000 pounds (which might be the drift of a 2000-ton vessel in a violent hurricane), the backward drifting force results in an increased displacement of the anchorage float of about 51,000 pounds, which, in turn, increases the strain on the anchoring cable 60,000 pounds. The result is the raising from the bottom of the ocean of such a weight of the anchor chain and cable as will produce the necessary downward strain at the angle derived by balancing the resulting forces.

A sufficient length of the anchor chain and cable will always remain on the bottom and cause the anchor to act always in its most effective position. The various forces resulting from wind and waves merely vary the displacement of the anchorage float and the length of cable in contact with the bed of the ocean.

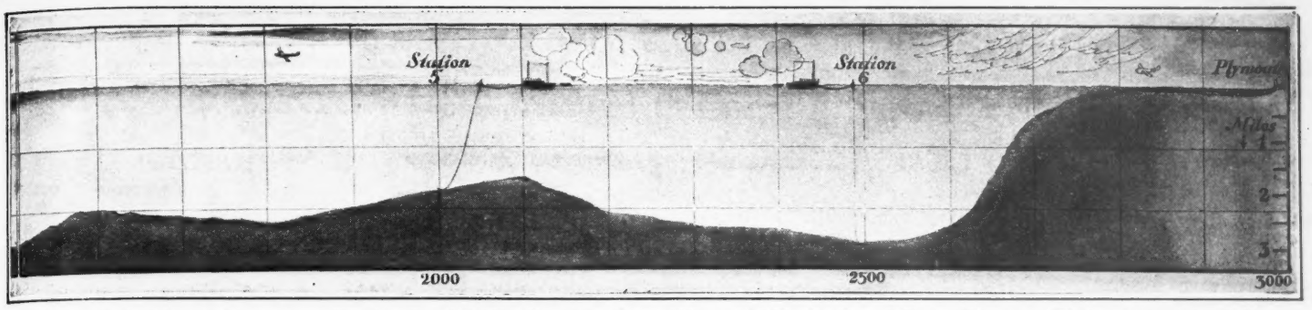
The inventor proposes to equip the sea stations, anchored at intervals of about 500 miles, with flying decks 180 feet broad and 800 feet long, available alike as landing fields for small, single-seated racing land airplanes or multimotored, heavy tonnage flying boats.

Each station also would have its radio equipment and operators, "trouble ships" to rescue disabled airplanes forced to descend to the water between stations, floating landing platforms for the benefit of seaplanes, complete crews of mechanics, spare pilots, and meteorological personnel and instruments, including kite balloons for conducting weather observations.

The vessels would also contain comfortable quarters for housing travelers who, because of darkness or inclement weather obtaining at the time or forecast, might prefer to wait over for a later transport.

In connection with the technical features of his project, Mr. Armstrong has worked out a detailed

The cable's weight and the float's buoyancy are adjusted so that anchor and chain are never lifted



land, joins the main route at Station 3, while Station 4 is the junction point for traffic from Spain, Portugal, and Italy *via* the Azores. Station 6 is the division point for traffic from Plymouth, England, and Brest, France. The system, extended beyond Plymouth, would include Belgium, Holland, Germany, Norway and Sweden

estimate of the required capital to put such a service into commission.

In this estimate he has assumed that with the establishment of regular airlines, all ocean mail of the first class between New York and Plymouth would be carried over them; that an equal weight in express would be available for transportation, and that 200 passengers would be carried daily over the route in each direction. This is about 10 per cent of the cabin passengers who now make the Atlantic passage by steamer. He proposes a mail rate to the government of $1.50 a pound and an express rate of half that figure, with passenger fares at $300 each, including the privilege of carrying 200 pounds of baggage.

On this basis, with a capital investment of $20,000,000, including surplus and working capital, the inventor has estimated an annual gross income to the operating company of $58,500,000 a year; a total operating cost of $37,500,000, making a total net income to the operators of $21,000,000.

The route selected for the proposed transatlantic service, with provision for five anchored supply and navigating stations 500 miles apart, is almost identical with the southern or summer steamship route to England, and is so located as to escape the fogs and icebergs of Newfoundland and storm conditions so prevalent in the region of the Azores. The stations would be available for all ocean airplane traffic between Canada, the United States, Great Britain, and the Continent.

America's First Automobile—And Its Giant Offspring!

NO single invention developed wholly within the 50-year life of POPULAR SCIENCE MONTHLY is so intimately present in the daily consciousness of us all as the motor car. But do you know who built the first automobile?

The honor is now claimed for Gottfried Schloemer, who drove a strange, tiny "horseless buggy" of his own design and construction through the streets of Milwaukee, Wis., in 1889.

From this inventor's crude "freak" of 33 years ago—the probable progenitor of the modern high powered motor car—has developed a gigantic industry in which $1,204,378,642 of capital is invested.

The amazing industry has grown too fast for its history to be written. In wonder at today's marvelous motor designs, we have even neglected the man who is said to have been the maker of America's first automobile.

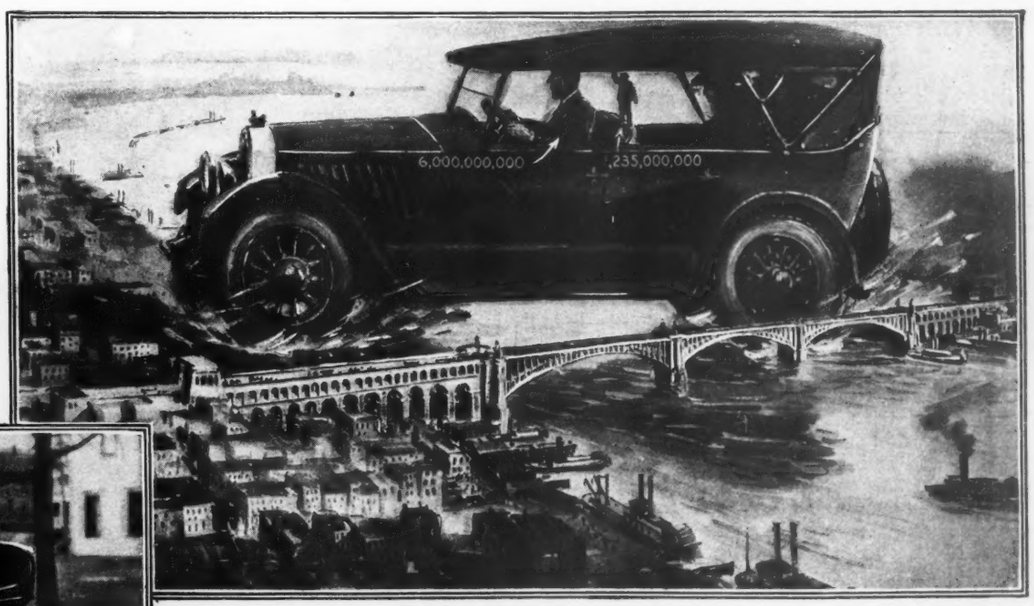
Mr. Schloemer's machine was hardly a car at all as we use the word today. Not until years later were the steering-wheel, pneumatic tire, and radiator invented. Spark plugs were unknown, and the one-cylinder motor with its 3½ by 3½ bore was fired by the obsolete "make-and-break" system. There was no carburetor until 1892, when a kerosene lamp gave the inventor the suggestion for the first ever patented. It consisted of a thick bunch of wicks that dipped into the tank. As the gasoline evaporated from the upper ends of the wicks, it was sucked into the intake. And that was only 30 years ago.

Today the auto industry is so vast that it is hard to comprehend. In the United States alone are registered 9,000,000 pleasure cars and 1,000,000 trucks. If these cars formed a procession, radiators against rear wheels, the line would extend over 16,000 miles. Half the population of the country could go auto riding at once, for there is a car for every ten people; but on all the state and national highways there would not be room for such a crowd.

Financially, the figures are as astounding. The automobile industry produced more than a billion and a half dollars' worth of cars and accessories in 1920, the banner year. This production included 2,205,000 vehicles worth $223,927,000; parts and accessories sold for $725,136,942, and tires valued at $636,750,000.

The giant progeny that grew from America's first car has exerted a tremendous influence on other industries. For example, 27 per cent of America's oil production is burned by the automobile, 24.6 per cent as gasoline, and 2.4 per cent as lubrication.

Eighty-three per cent of the cars registered in the world are owned in the United States.



The present size of America's motor car—the giant 30-year-old progeny of the tiny machine shown at the left—almost bewilders the imagination. Last year motor cars carried 6,000,000,000 passengers, as compared with 1,235,000,000 transported by all railroads combined. At last count about 10,000,000 automobiles were registered

Steering wheel, radiator, and pneumatic tires were unknown when Gottfried Schloemer's "horseless buggy" appeared

Yesterday and Tomorrow as They Look Today

Nation Builders, Peering into the Future, Foretell Developments Destined to Overshadow Progress of Past Half Century

The busiest street corner in the world—Fifth Avenue and Forty-Second Street, New York—as it looked 50 years ago. The contrast between its deserted calm and the skyscraper-shadowed, motor-harried crowds that seethe through the same streets to-day is hardly less striking than the contrast between the same corner to-day and the way it may look 50 years hence, as shown at the right

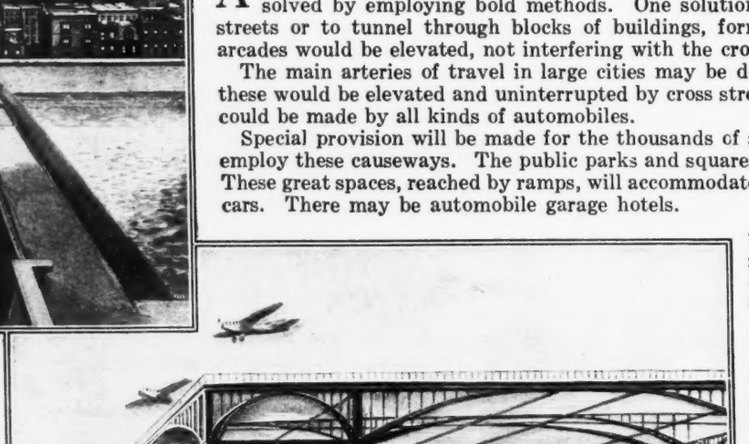
Arcades to Relieve City Traffic

By DR. JOHN A. HARRISS, Traffic Commissioner, New York City

AS our cities become more congested, the traffic problem can only be solved by employing bold methods. One solution will be to cut new streets or to tunnel through blocks of buildings, forming arcades. Such arcades would be elevated, not interfering with the cross streets.

The main arteries of travel in large cities may be double decked. Since these would be elevated and uninterrupted by cross street traffic, high speed could be made by all kinds of automobiles.

Special provision will be made for the thousands of automobiles that will employ these causeways. The public parks and squares can be undermined. These great spaces, reached by ramps, will accommodate tens of thousands of cars. There may be automobile garage hotels.



Vast arcades, tunneling through massive business blocks; skyscraper garages—great downtown hotels to house thousands of automobiles; elevators carrying commuters to spacious airplane landing stations above the highest roofs—all these may be everyday sights in our large cities 50 years hence. Even now, a 25-story "motor hotel," such as that pictured at the left, has been planned for Chicago at a cost of $1,200,000, with housing capacity for 1100 automobiles, while every other detail in this scene is based on some authoritative proposal

Highway Bridges

THE increasing importance of highway traffic, due to the development of the auto, will call for unprecedented activity in building huge bridges like the Hudson River structure with a central span of over half a mile, and a capacity of 12 railroad tracks, a roadway 150 feet wide, and four trolley lines.

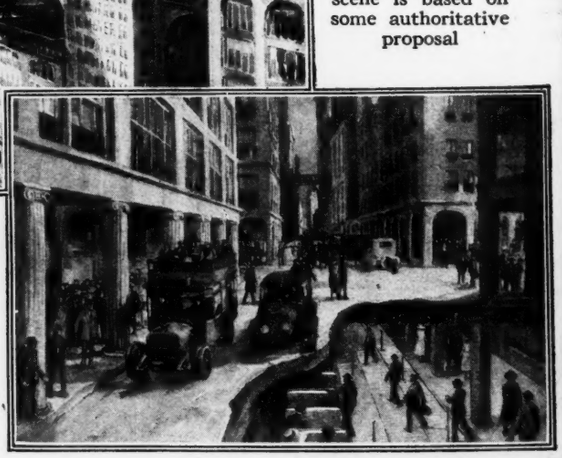
Better Highways Will Multiply Autos

By ALFRED REEVES, General Manager, National Automobile Chamber of Commerce

WITHIN the next decade there may very possibly be 15,000,000 motor vehicles on the highways, some economists predict a larger number. This growth is likely to come gradually, as our highway systems develop and as city traffic conditions adapt themselves more fully to motor travel.

There will be an increase in the 3,000,000 cars now owned in rural districts, because the farmer cannot afford to be without a car.

The movement toward the suburbs manifest everywhere during the past 10 years will continue to be augmented through motor travel and in turn will increase the demand for automobiles.



Endless moving sidewalks running at two, four, and six miles an hour and bordered by seats moving at a greater speed have already been planned for New York

YOU have many times seen pictures of the scenes of 50 years ago contrasted with the world we know to-day. Have you ever compared scenes of 50 years ago with the world as it may be 50 years hence? Spanning—with the aid of a little history and a little imagination—the hundred-year cycle that is most interesting to each of us, *Popular Science Monthly* presents in this anniversary issue a few glimpses of what the next half century of science may bring us.

The little life stories of six typical inventors of the past 50 years, appearing on other pages, mirror the romance of a great period of scientific progress.

In coming years, one of the most spectacular engineering feats will doubtless be the Colorado River water power development, described on page 55. To report this vast, forward-looking project for the Anniversary Issue, *Popular Science Monthly* sent John Anson Ford on an arduous 400-mile desert trip.

Similarly, on other pages you will find articles that set the imagination probing the future or dwelling a moment on the past. Meanwhile, the pictures and articles on these immediate pages, based on actual prophecies by real authorities, may stimulate your own imagination to a more comprehensive vision of the great things coming in the new era.

A Vision of Rapid Transit 50 Years Hence

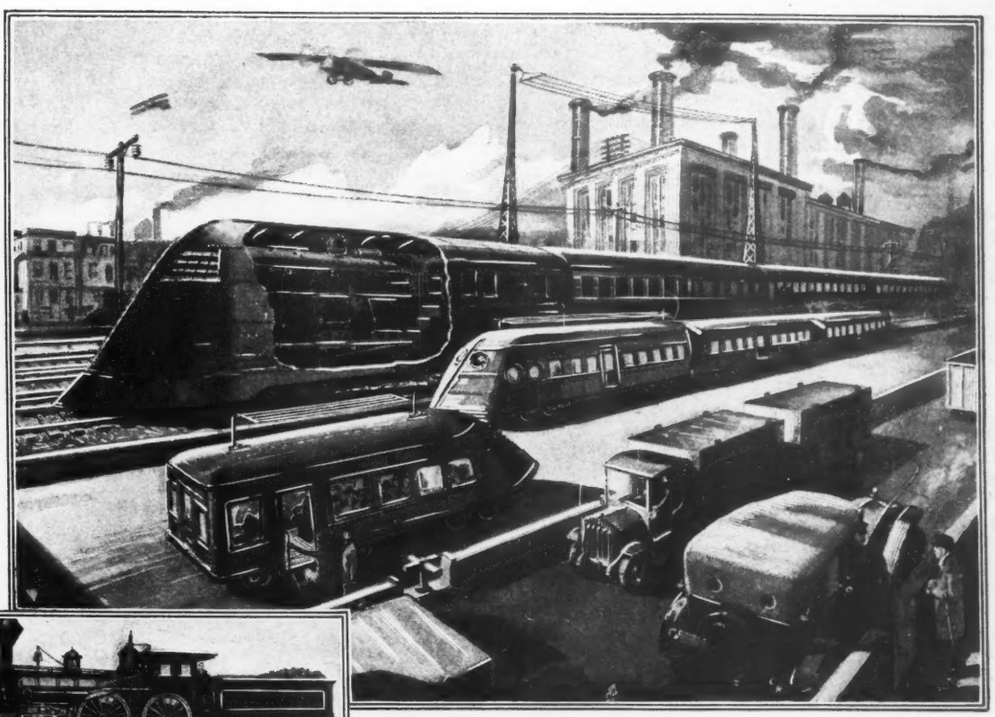
By ROBERT S. BINKERD
Of the Association of Railroad Executives

THE mileage of tracks will be increased in the future, not by the construction of new railroads, but by double-tracking the single-track roads and by triple or quadruple tracking the present double-track lines.

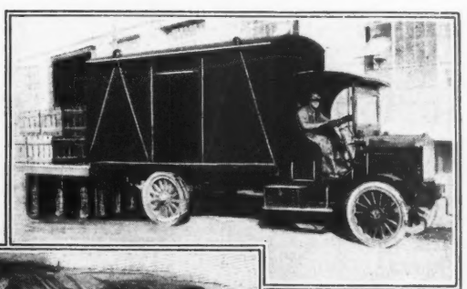
Great changes will be made in the hauling of freight. The freight car of the future will be simply a chassis that will carry one or more containers easily detached. These units may be loaded and carried if necessary on auto trucks and transferred quickly and cheaply to the chassis. At the end of the journey they can be easily removed from the trucks, thus saving an immense amount of handling. The mails, for instance, can be loaded in the containers at the post offices, and lifted on the chassis of the cars, saving probably half a dozen transfers in which the bags must be handled one at a time. At present a container holding 20 tons of mail is often loaded and unloaded 10 times in shipment from one city to another. This is equivalent to handling 200 tons.

Locomotives in use 50 years ago appear as midgets beside those of to-day. The locomotives of the future, designed with streamlined bodies, will attain greater speed than ever before. Running time will also be reduced by improving grades and building cut-offs.

Short-haul passenger traffic will be handled by a combination of automobile and railroad car. These rail cars, run by gasoline, will reduce the cost of operation about 50 per cent, and will attain a speed of a mile a minute.



Fifty years ago people were accustomed to the locomotive pictured at the left. Compare this midget with the automobile trains and streamlined locomotives predicted as the next step



Even now, freight cars are becoming mobile platforms carrying unit containers that may be easily detached and transferred by derrick to auto trucks for delivery, thus saving an immense amount of freight handling

The Sky Is the Limit for Airplanes

By GROVER C. LOENING, Head of Loening Aeronautical Engineering Co.

TEN years ago, when I predicted a speed of 100 miles an hour for airplanes, the prophesy seemed fantastic. Today 150 miles is common. The Atlantic has been crossed in 16 hours, while the United States may be crossed to-day in 48. The airplane capable of a sustained speed of 200 miles an hour will probably soon be realized.

The next great step in flying will be the perfection of some new and better means of driving the machines. Instead of the cumbersome combustion engines and fuel tanks, the machines may be driven by compressed-air jets. An immense increase in speed and cargo space will thus result.

The future form of the airplane is uncertain. The monoplane has proved to have so many advantages, that development may lie along this line.

Marine Engines Will Improve

By ALBERT D. LASKER, United States Shipping Board

THE past 20 years have shown almost as great a change in the characteristics of the world's merchant fleets as was to be found in the entire history of steamshipping before 1900. The turbine, the oil-burning boilers, the geared turbine, and the internal combustion engine are products of the past 15 years alone.

The size and speed of the cargo ships have steadily increased, though, paradoxically, the extreme size and speed once popular for special passenger ships is now considered impossible because of construction costs. Cargo handling gear has been greatly improved. The use of electricity on board ship has become almost universal, while the tremendous strides in radio make possible communication at sea.

We seem to have reached the maximum efficiency of the steam generating plant as applied to marine propulsion, in the modern turbines. For the long hauls steam will be unable to compete with the internal combustion engine.

It would seem probable that some combination of steam engine and internal combustion engine will be evolved to give a decreased weight and size to the horsepower.

The popular type of passenger ship for the next few years will be of about 20,000 gross tons, making around 18 knots.

Famous Scientists Forecast Future of Wireless

By PROF. MICHAEL I. PUPIN

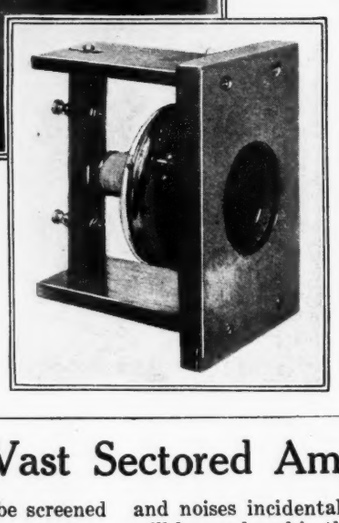
Noted Scientist and Inventor

WIRELESS electricity is doubtless on the eve of a remarkable development. New York is to-day the radio center of the world. Radio should not be considered a mere toy, but seriously studied and mastered. The day may come when every newspaper, however remote, will be in instant touch by radio with the news centers of the world.

The educational possibilities are very great. When there is a great preacher—and they are rare—radio will make it possible for thousands of congregations to listen to him. The lecturer in the college will be able to address tens of thousands of students.

We are far behind in the building of cables. The war served to check cable laying for five years and it will take many years to catch up with normal conditions. Therefore radio communication is destined to play an immensely important rôle in our civilization. Its present wonderful development is merely a beginning. I was present at the opening of the most powerful radio station in the world when a message was broadcasted to 28 countries.

The great bulk of radio traffic in the future will be by means of regular telegraph messages, rather than by radiophone. Since many countries sleep while others are at work, it would be impossible to transact business by speech. The difference in language is another consideration. There is, besides, the chance of being misunderstood in talking over the telephone, whereas a telegraph message gives a definite record.



From the first crude telephone transmitter (at right), to the future apparatus for seeing as well as hearing by electricity (above), is the tremendous step conceivable during the present century of electrical communication. Soon, according to Nikola Tesla, as you talk over the phone, you may see in the attached eyepieces the face at the other end of the wire, while, caught in the multicelled screen before you, your own features will be likewise transmitted

By NIKOLA TESLA

Electrical Engineer and Discoverer

IT will soon be possible to see as well as hear by means of electricity. "Television" will be employed as generally as telephoning. As one listens to a voice at the other end of the line, he will also see every expression of the speaker's face.

It will be possible to see as well as to hear either by the wireless telephone or over the regular wire circuits. There will be no limit to the distance of such transmission, so that we shall be able to talk to a person in any part of the world and watch his face at the same time.

In a general way the instrument used for television will closely resemble the mechanism of the human eye. Success in transmitting vision depends upon four things, and of these I have already perfected two.

The radio transmission of sound will also be developed in the future far beyond the present system. It will be possible not only for any person with a station to listen in, but also to transmit at the same time to every other station. I have already accomplished this in my experiments.

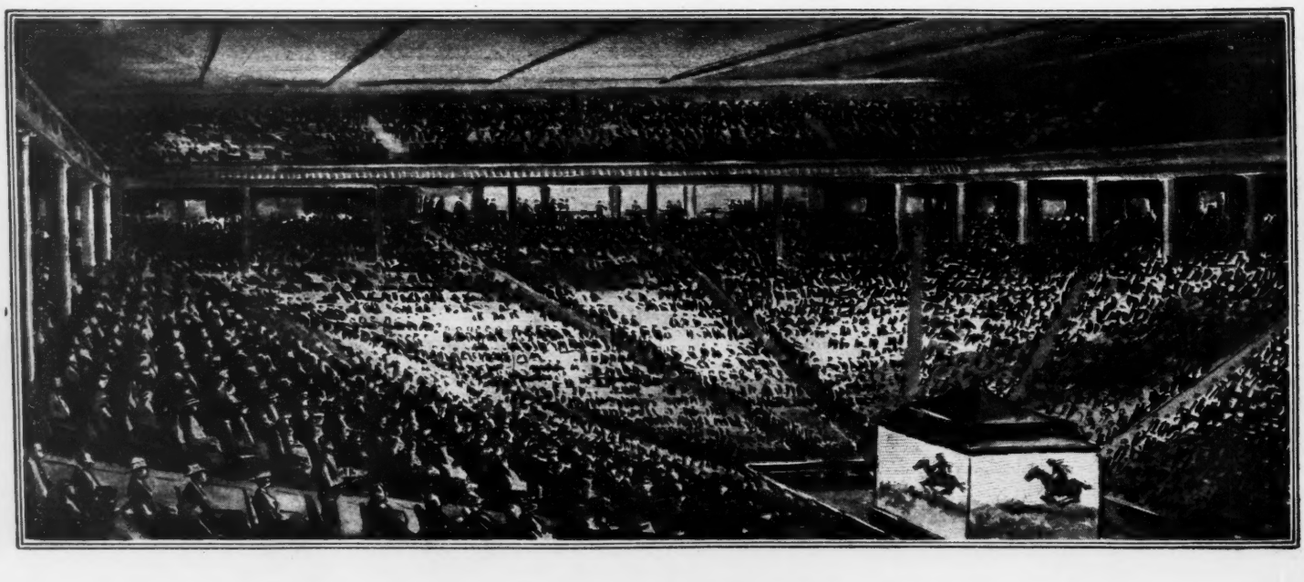
The Movie House of Tomorrow—A Vast Sectored Amphitheater

CONCENTRIC circles of seats divided into sectors, each sector facing the center of a mammoth amphitheater and provided with its own screen—such may be the motion-picture house of the future, as predicted by far-sighted motion-picture engineers.

Pictures for all sectors will be screened from one film.

Seats will be designed by experts in correct posture, to promote comfort and health, and will fold automatically as soon as vacated.

All the master sounds—music, speech, and noises incidental to the film story—will be produced in the acoustic laboratory of the theater adjoining the projection room. These sounds will be delivered automatically in synchronism by direct connection with the film through a telephone attached to the auditor's chair.



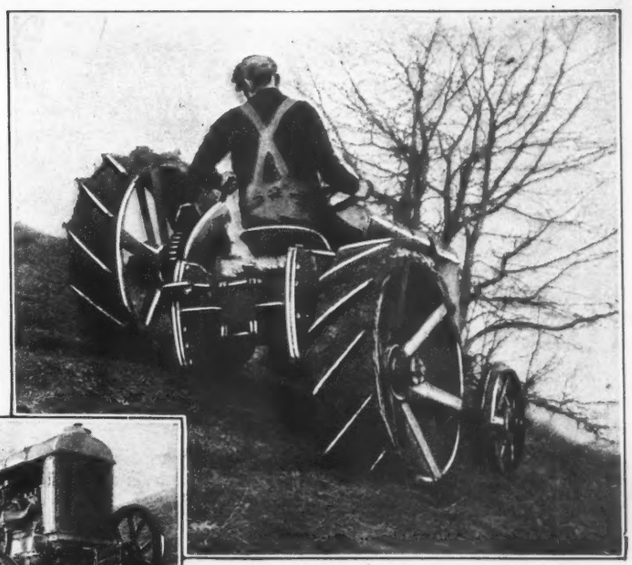
Farm Tractor Can Ride Steep Hillside on Even Keel

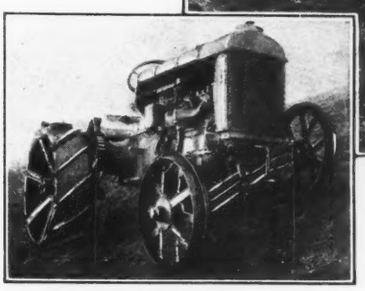
OPERATION of farm tractors on steep hillsides has been made possible by the perfection of new wheel mountings that hold the body of the tractor on the level.

Most tractors have been unable to work on severe grades, since there has been no means of stabilizing the machines. They have tended either to slide downhill or turn over. In the great wheat-growing areas of the Northwest, where steep hills are planted to grain, this has been a great handicap.

The mountings invented by E. G. Adams, of The Dalles, Ore., enable the operator to keep the chassis level, even when the wheels on one side are more than two feet higher than those on the other. The front axle consists of three parallel bars, pivoted in the center and at the ends, which conform to the ground automatically on the principle of an adjustable parallelogram. The rear wheels are controlled by a lever that meshes a special gear wheel with the tractor drive shaft and turns a worm gear in a semicircular rack. This moves the hubs of the rear wheels to any angle and locks them in the desired position.

The device is thus operated with power given by the motor, the driver merely shifting the control. By means of the control the driver can throw the balance of the tractor to the left, right, or center, as desired. The changes may be made either when the tractor is standing still or when it is in motion.



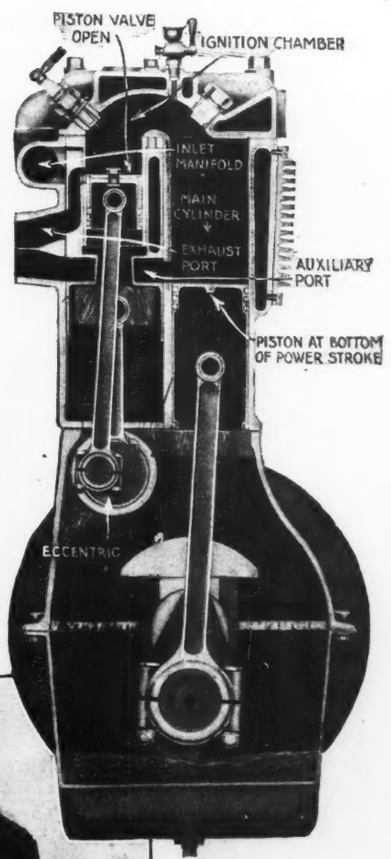


On a hillside with an incline of 41 degrees, the chassis and engine of the tractor shown above remain on the level. Note how the operator, by means of a lever, adjusts the rear wheels to conform to the grade. The front axle, composed of three adjustable bars, conforms to the ground automatically, as shown at left

Slide Valve Saves Oiling Troubles

LUBRICATION and seating troubles with the valves of an automobile motor will soon be woes of the past, according to E. R. Burtnett and H. A. Brunell, engineers of Los Angeles, Calif., who have recently patented a slide or piston valve, the operation of which is much like that of valves on a steam engine. The valves slide, but never leave their seats as does a poppet valve. They are oiled by splash from the crankcase and will give any port area desired.

The valve consists of two small pistons moved one within the other, and both working in an auxiliary cylinder with its axis parallel to the main cylinder. The usual expansion rings keep the piston-valve tight, and the links connected with the eccentric shaft insure positive opening of the fuel and exhaust ports, irrespective of the revolution speed. The quickness of opening, and the greater area of inlet and exhaust, it is claimed, eliminate the overheating of exhaust valves and, by reducing the cylinder temperature, secure better compression and fuel economy.



Above is a cross sectional view of the main and auxiliary cylinders at the end of the power stroke, with piston valve and auxiliary ports open to quickly release spent and hot gases. At left: The four cylinders with valves in place

Make Your Camera Tell the Story

ON other pages of this issue appear the three subjects that won $50 in prizes awarded in POPULAR SCIENCE MONTHLY'S camera contest for May. Look at these pictures and discover the quality that made them winners. Each tells a story of mechanical achievement.

Pictures such as these will win in the June contest. And you may be one of the winners. Look about you. Send POPULAR SCIENCE MONTHLY interesting photographs from your community—pictures of new inventions, engineering triumphs, or personal adventure.

Best Photos Win $50

THE winning pictures in the May contest appear in this issue as follows:

FIRST PRIZE, $25—**H. E. Thomas,** Portland, Ore. Subject—"Pipe Pushed Through Earth Lays Itself" (see page 34).

SECOND PRIZE, $15 — **Anthony Robinson,** San Marcial, N. M. Subject—"Compressed Air Does Work of Engine 'Wipers'" (see page 44).

THIRD PRIZE, $10—**Frederick J. Miller,** Silver City, Ia. Subject—"Paint Brush Replaces Old Paint Can" see page 48).

Will your name be in the June list?

"Gipsy" Flier Thrills

SPEAKING of June, there's a thrilling story of a vagabond airman's experiences in the next issue of POPULAR SCIENCE MONTHLY. Have you ever heard the story of the "gipsy" flier's adventurous profession? One of these wanderers of the skies tells of the strangely fascinating life he and his fellows lead, recalling the romance of old frontier days.

AERIAL: As the sound passes into the transmitter, the aerial is instantly charged and discharged with electrostatic impulses
INDUCTANCE: By varying the number of turns on this coil the length of the wave can be adjusted
VACUUM TUBE—Changes the frequency of the electric waves from about 4000 to 500,000 or more a second
TRANSFORMER: By increasing the number of turns of wire in the transformer, current from the storage battery is changed into a current of high potential
TRANSMITTER: Sound waves strike the metal diaphragm and the latter, by changing the pressure of carbon grains, allows more or less current to flow
STORAGE BATTERY: Used to supply the power source at the sending station. High power broadcasting stations use large generators

Perry Makes Clear the A B C's of Radio for Everybody

A Simple Picture Story of How Wireless Outfits Work

By Armstrong Perry

WHEN Mrs. Brown hangs out of the upstairs window and talks with Mrs. Jones, who is draped across a similar sill on the opposite side of the street, the conversation raises no scientific question in the minds of outsiders who listen in, unless it may be some speculation as how the ladies acquired the lung development to compete successfully with a trolley car, a street piano, a banana peddler, and a backfiring automobile. We are used to it.

All a Mystery—At First

Nor do we ponder very deeply over the problem of how we are heard, when we speak into the telephone, by a friend at the other end of town. If we are talking from Chicago to Milwaukee, we simply talk as much louder as we think necessary to cover the increased distance. We are used to the telephone, too.

But when we string a wire with one end stopping at a porcelain knob and the other end stopping at a cabinet sprinkled with knobs, listen in, hear voices that we know and others that we do not know, we are gripped by a sense of great mystery. "How can it be?" we ask.

The use of air to shoot the energy through is no more mysterious than the use of wire. It is newer, that is all.

When you speak into a telephone transmitter, whether it is connected with a wire line, or with a radio line, your vocal organs produce sound waves that strike a thin disk of metal visible just inside the hard rubber or metal mouthpiece. They set this disk to shimmying. Behind the disk is a small quantity of carbon granules. Through this carbon flows a current of electricity. The carbon is not a very good conductor. It resists the flow of the current, somewhat as sand in a waterpipe retards the flow of water. The disk, or diaphragm, which is set in motion by the sound waves of your voice, presses upon the carbon when your voice drives it in, then relaxes its pressure as the spring of the metal makes it fly back. This varies the resistance of the carbon to the current, somewhat as packing the sand in the waterpipe, then loosening it again, would change its resistance to the water.

From Sound to Electricity

Your voice, so far as the phone is concerned, stops right at the diaphragm. From that point the apparatus carries electricity, not sound. If it carried sound, you would have to wait about three minutes for your friend a thousand miles away to hear your "Hello," and three more for his "Hello" to come back to you. But electricity (thanks be!) will circle the globe seven and one half times in the second of time that sound requires to travel 1080 feet!

From the disk to the listener's earpiece the wire line telephone or the radiotelephone handles electric currents. The direct

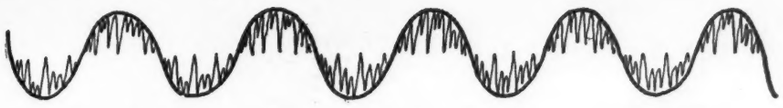
Everything You Want to Know about Radio

KEEPING a step ahead of the whirlwind demand for news of wireless developments, *Popular Science Monthly* is now endeavoring to publish the best all-round radio information available anywhere for the non-technical man. The variety of articles on this subject in the present issue is a foretaste of the helpful radio features to come.

Send your radio problems to our Information Department, enclosing a stamped, self-addressed envelope for reply.

Don't miss the following radio articles in this issue:

The Culminating Triumph of Science, Editorial, page 4.
It Is Easy to Make a Two-Stage Receiving Set, page 76.
Offer of complete working drawings for the above, page 84.
How to Construct a Neat Radio Cabinet, page 77.
How to Adapt Your Phonograph to Receive Radio Concerts, page 78.
Famous Scientists Forecast Future of Radio, page 28.
Radio Interference—Its Causes and Remedies, page 42.
Jack Binns, First Radio Hero, to write for Popular Science Monthly; see important announcement, page 42.



current that flows through the carbon in the transmitter is varied from instant to instant by the changing resistance of this substance caused by the varying pressures of the diaphragm as it responds to the sound waves.

A little farther on the current runs through a "transformer." This piece of apparatus does two things to the current: It "steps it up" and changes it from a pulsating, direct current to an alternating current. The stepping-up is like running a one-inch stream of water through a quarter-inch nozzle at the end of your garden hose. You do not get any more water, but the stream under which you could safely hold your hand when it flowed directly from the spigot hits you so hard that it stings when it issues from the nozzle, because the pressure has been increased.

The change from direct to alternating current is a change of movement. The course of a direct current resembles that of the tire on a jacked-up auto wheel when it turns, moving continuously in one direction. The alternating current moves like the rim of the balance wheel of your watch, going around its circuit in one direction, then back in the opposite direction. The change from one-way motion to two-way motion is made by interrupting the flow of the direct current at frequent intervals as it passes through one coil of wire in the transformer. A one-way current passing through a wire in spurts sets up a two-way current in any wire near it, for reasons that are explained later. At the start of each spurt the current in the secondary coil of wire in the transformer moves in one direction. At the end of the spurt it moves in the opposite direction.

This alternating current, reversing its direction many times a second, is turned into the antenna of the transmitting radio station. The antenna is the wire strung above the roof, or whatever takes the place of this wire. It is a little hard to understand how there can be an electrical "circuit" when the antenna simply stops short out in the air somewhere, while at the lower end the ground wire that leads from the apparatus to the earth just stops there. The current cannot flow through the air from the outer end of the antenna to the lower end of the ground wire. But between these ends, when electricity flows in the wire, there are lines of force that complete a radio circuit. It helps to fix the idea in your mind if you think of this "open circuit" as a child's iron hoop that has parted where it was welded together and that has been repaired with rubber bands that complete the circle though they do not keep the ends of the metal in contact.

In this open circuit the energy flows back and forth, changing direction perhaps as many as 200,000 times a second. The lines of force in the open space serve as a sort of spring. The current accumulates pressure as its progress is stopped. It is thrown back around the circuit. It accumulates pressure again. The lines of force throw it back again. This process is repeated over and over.

The current is supplied by a generator of some kind. It may be a machine that produces electricity by whirling coils of wire through lines of magnetic force, or it may be a battery that produces current by soaking minerals and metals in chemical solutions. The machine or battery delivers the current at a fairly regular pressure, or voltage, and in fairly regular quantity. But your voice, agitating the diaphragm of the transmitter into which you talk, pressing it against the carbon granules, and changing the resistance of these granules to the current as it flows through them, causes changes in the current similar to those that every one has produced in a stream of water issuing from a garden hose by putting the thumb over the nozzle and wiggling it. These changes pass right on into the alternating current that flows in

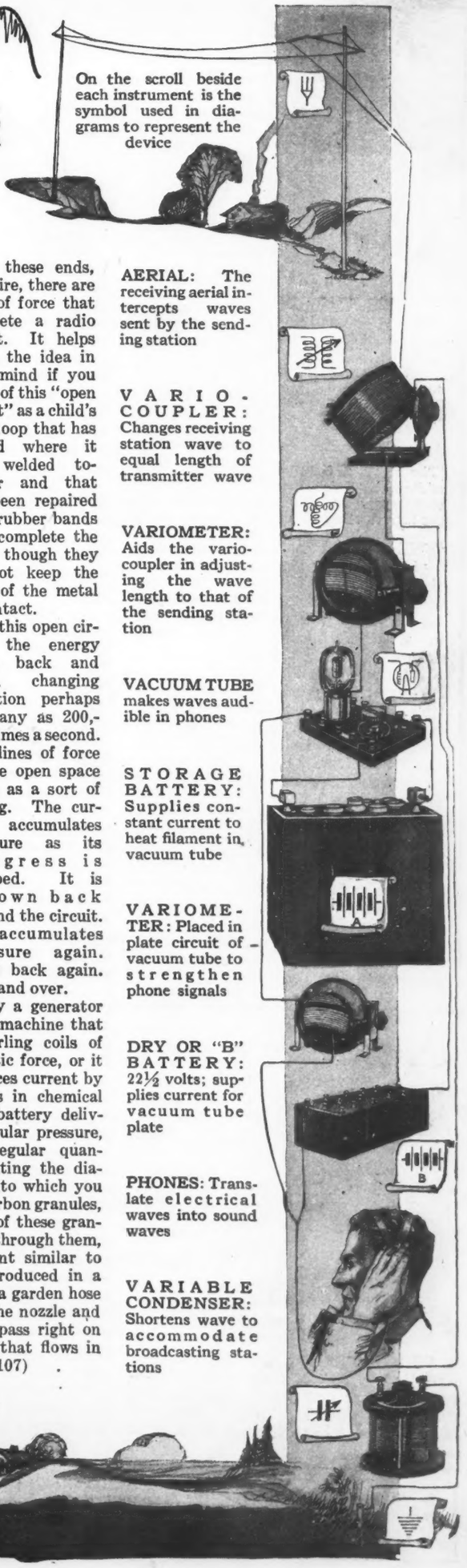
(*Continued on page* 107)

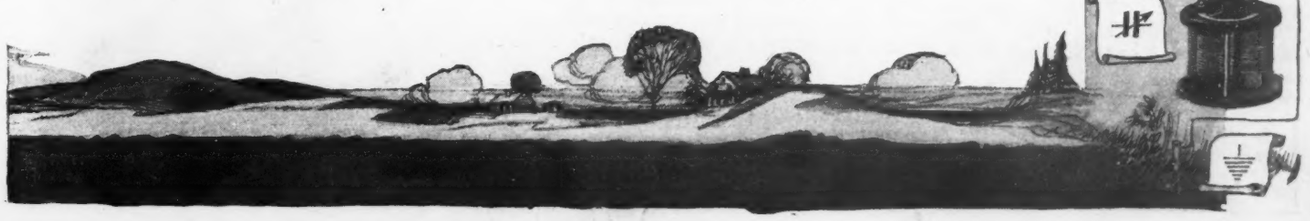
The Wealthiest, Most Powerful, Best Liked, and Most Hated Man in America—Who Is He?

FORTY years ago he was an unknown mechanic on a farm. Within the past twelvemonth a dramatic series of events has given him industrial strength unequalled in history.

You know Henry Ford's name, but how much else do you know about him—his personality, his purposes, his feeling toward *you* as a fellow being?

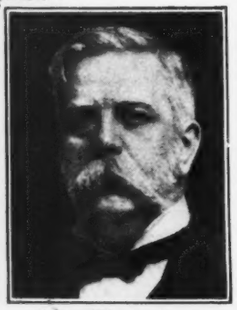
Next month's POPULAR SCIENCE MONTHLY will contain a startling interview and close-up word portrait of Henry Ford—as plain man and as giant of industry—that no reader informed in world affairs should miss.


On the scroll beside each instrument is the symbol used in diagrams to represent the device
AERIAL: The receiving aerial intercepts waves sent by the sending station
VARIO-COUPLER: Changes receiving station wave to equal length of transmitter wave
VARIOMETER: Aids the vario-coupler in adjusting the wave length to that of the sending station
VACUUM TUBE makes waves audible in phones
STORAGE BATTERY: Supplies constant current to heat filament in vacuum tube
VARIOMETER: Placed in plate circuit of vacuum tube to strengthen phone signals
DRY OR "B" BATTERY: 22½ volts; supplies current for vacuum tube plate
PHONES: Translate electrical waves into sound waves
VARIABLE CONDENSER: Shortens wave to accommodate broadcasting stations



The Genius of Transportation

How Perfection of the Airbrake Paved the Way for Scores of Epoch-Making Inventions



Often Westinghouse, in silk hat and frock coat, was found puttering over inventions in his shops

George Westinghouse

[The story of George Westinghouse, one of *Popular Science Monthly*'s greatest contemporaries, who blazed the trail for the introduction of science into industry.]

THE best investment George Westinghouse ever made was in a magazine, not because he wanted the publication, but because the agent who took his subscription while he was at work in his father's machine shop at Schenectady, N. Y., in the summer of 1866, was a remarkably pretty girl.

George, being only 20, was susceptible. He never saw the girl again; but in the magazine he read about the use of compressed air in drilling the Mont Cenis tunnel. That gave him the idea of the airbrake; and the airbrake later gave him the money to develop 400 patents, covering a wide range, and to organize no fewer than 105 manufacturing corporations in the United States and Europe, most of which are still in existence and many of which do a world-wide business.

As a prolific inventor of epoch-making devices and a great business man as well, George Westinghouse has never had an equal.

His first patent, obtained in 1865, when he was barely 19 years old, was for a rotary steam engine. As an engine it was a failure; but, remembering the story of the boy who drew a picture of the minister and, finding it unsatisfactory, added a tail and called the picture a dog, Westinghouse turned his engine around and thus produced an excellent water meter, the manufacture of which became an important industry.

Soon afterward he invented a car replacer and a railroad frog, which provided the foundations for a nice little business that started the young man in life. Before he was 21 he met another pretty girl—on a train. That night he told his father and mother he had found the girl he was going to marry, which he did a few days later.

His impetuosity in love was typical of Westinghouse's whole career.

First Tests Shocked Passengers

At the historic Burlington trials of his airbrakes in 1887, the shocks in the rear car of the 50-car train were so great that observers and recorders were hurled the length of the car and one broke a leg. Westinghouse was the only man who believed the airbrake, which had been greatly improved since the first passenger train was equipped in 1869, would ever be a success for long freight trains. In three months Westinghouse had changed the airbrake to a form that endured for 20 years, and in another month had convinced the world that the longest freight trains could be braked by air.

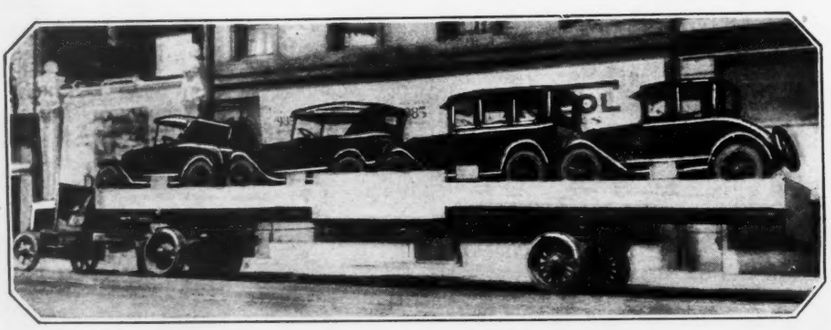
Westinghouse was a tireless worker. Seized with an idea, one New Year's eve, he called a foreman and ordered eight men to work on the holiday. He worked with the men all New Year's day without stopping for lunch until the job was finished. Then he gave the men $50 to buy an extra good meal.

Westinghouse carried neither notebook nor pencil; and as he was always figuring on something, he was forever borrowing pencils. He undoubtedly borrowed more pencils than any other man who ever lived. Sometimes, while waiting for a meeting, he could be found in the shops, in silk hat and frock coat, puttering over some new device. He didn't need notebooks. It was a proverb among his employees that "you must not tell the 'old man' anything you don't want him to remember 10 years later." Things stowed themselves in his mind and came out when wanted.

He had a powerful body, well over six feet tall, and perfect health. No wonder that in one period of eleven years he took out 134 patents, organized six great corporations, developed the airbrake through its one great crisis—thus making possible the present railroad transportation system — and started the alternating current system, without which modern electric developments would have been unthinkable.

People thought the airbrake more dangerous than a wreck when its trials in 1887 hurled observers the length of the car

Auto Show on Wheels Tours Highways



MOUNTED on two great 12-by-12-inch timbers 60 feet long, extending between a truck and a trailer, a traveling automobile exhibit is touring the highways of California. The platform makes a truck 75 feet long over all, and gives room for four cars.

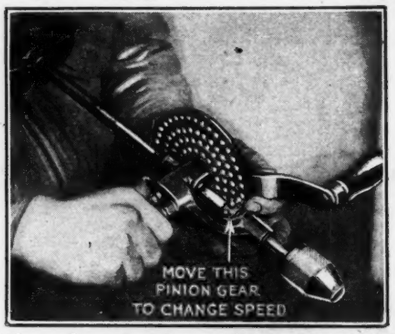
The unit attends all auto shows and stops at towns too small to support an agency. A runway can be placed against the truck.

HOW can a repetition of the Roma airship disaster be prevented in the future? Read in the June issue a detailed description of plans for a sensational airship buoyed up by a vacuum.

Perforated Disk Forms Breast Drill Gear

FOUR separate boring speeds have been provided in a newly invented breast drill in which the usual toothed crown wheel, with its bevel gear, has been replaced by a disk with four concentric circles of conical holes.

A pinion gear sliding on the drill spindle has pointed pegs that mesh with these



holes. Gear speeds are changed by sliding the pinion on the drill shaft from one circle of holes to the next.

You Can Set a Watch by New Pocket Sundial

THE camper or fisherman who uses a newly designed pocket sundial will have not only a means of knowing the exact time whenever the sun is shining and wherever he may be, but will learn also a good deal about terrestrial magnetism and the subject of the "time" itself. The tickless timepiece is an accurate and scientific instrument.

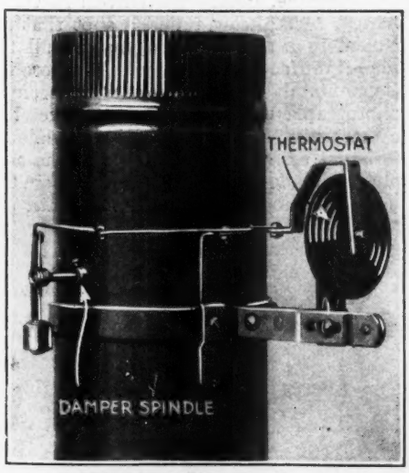
In use, the stylus, or pointer, is set to correspond with the latitude of the place. For this purpose a compass with the proper table of variation has been provided in order that the instrument may be pointed due north.

A second table gives the equation of time, which is the difference between the time by the sun and that shown by a watch. With these corrections made, it is safe to set a watch by the pocket sundial. Three dials are provided, so that the pointer may be set for 35, 40, or 45 degrees of latitude.

Automatic Damper Works Like an Incubator

THAT a new automatic damper—designed for use on ordinary heating stoves—can effect a saving of 25 per cent in fuel, has been confirmed in recent tests. The fuel economy is due to an accurate regulation of temperature. The damper employs the principle used in many incubators, being so constructed that it will close as soon as the room temperature exceeds a certain predetermined point.

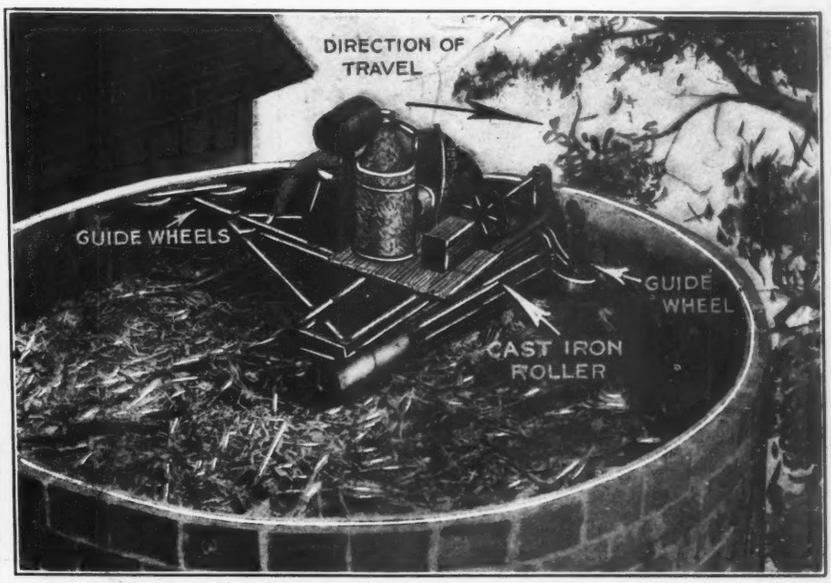
The regulating mechanism consists of a thermostat fastened to the stovepipe and filled with a volatile liquid. When the fire becomes so hot that the liquid boils, the thermostat expands, and this pressure acts upon a lever connected with the pipe damper, either closing the damper altogether, or partially shutting it.



When the room becomes too hot, a thermostat closes the stove damper

Besides keeping the room at uniform temperature, it is claimed that the new device prevents danger of fire.

Machine Tamps Fodder in Silo Tower



PACKING down silage by a machine tamper, to insure thorough compression of the fodder and increased capacity for the silo tower, is now possible with the perfection of a combined tamper and roller driven by a two-horsepower gasoline engine.

The device consists of a cast-iron roller, shaped like a truncated cone and fluted toward its outer end. Since the roller tapers from a diameter of 20 inches next the wall to eight inches at the center, it will turn round and round in the tower, guided by two sets of horizontal roller wheels that are always in contact with the tower walls.

A broad wheel in the rear supports the platform carrying the engine and the one man needed to operate the packer. The weight of the machine compresses the silage as it is thrown into the towers by cutters outside.

LIGHTS FLASH WHEN DANGER POINT IS REACHED
GRAINS PER GALLON-SALT
HOLDER—CONTAINING TWO GOLD ELECTRODES—INSERTED IN LIQUID

Meter Will Automatically Analyze Boiler Water

A CONTAMINATION meter is a simple automatic indicator for measuring surface condenser leakage and salt-water contamination in boilers. It is necessary only to place electrodes in the water and read the salt content on a dial.

The principle on which the meter is based is the fact that pure water has a high electrical resistance, and that the addition of a small quantity of salt or acid changes the water to a good conductor of electricity. Compensating coils are used to cancel the influence of temperature. After this correction is made, the conductivity of the solution is a direct and accurate index of its chemical condition.

AS a special service to readers, the Editor will be glad to supply the names and addresses of manufacturers of devices mentioned in POPULAR SCIENCE MONTHLY.

The Wind Will Play Real Tune on This Flute

THE wind, becoming a musician, can play a real tune when assisted by a strange flute recently demonstrated. When the triple mouthpiece of this flute is held to face the wind, the air blowing through the instrument can be controlled to play a scale of eight notes.

To play this flute the musician holds the triple mouthpiece to the wind

On windy days, the performer can play any simple melody, and if he attaches a small windmill that turns a wooden cylinder covered with plugs manipulating a set of automatic stops, the wind can be forced to play a series of tunes automatically. The player element is arranged like the control wheel of a hurdygurdy.

Pipe Pushed through Earth Lays Itself

Above: Pointed pipe held in its carriage. A five-foot sweep of the handle (at right) advances carriage one inch

A PIPE-LAYING machine that pushes the pipe through the soil between pits dug at intervals of about 30 feet along a street is eliminating costly excavation work and continuous trenches in Portland, Ore.

When the machine is in action, the pipe is held in a carriage that moves along a steel runway. Two short handles adjust an eccentric so that the pipe is held firmly. A long handle works on the same principle as a jack, advancing the carriage one inch for every five-foot sweep. After the pipe, with its pointed steel end, has been driven into the soil for 18 inches, the carriage is returned to its original position for another shove.

The inventor finds that two men operating the handle are able to exert on the pipe a pressure of 20 tons, which is sufficient to drive a pipe of ordinary size through any soil unless rock is encountered. A one-inch pipe can be laid in this manner by a single workman.

Where the soil is easy to penetrate, as much as 150 feet of pipe has been shoved ahead from one location without deviating from a straight course.

Mechanical Instructor Teaches Waltzing

NOW comes a simple mechanical dancing instructor, invented by C. G. Sweet, a dancing master of Los Angeles, Calif., not only to teach, but to force awkward beginners to make their feet behave and to turn always in the proper direction.

Whereas a human teacher can merely guide his pupil, the new mechanical master, it is claimed, makes anything but correct dancing physically impossible.

To take his lesson, the pupil puts his arms through two metal rings fastened by cords to a strong spring hooked into the ceiling. Placing a chair directly under the swivel to which the spring is hooked, he hauls the cords taut and dances around the chair. In doing so he is compelled to turn in the direction of the sliding foot, performing the second movement of the waltz. This, according to the inventor, is the secret of threading one's way gracefully through the mazes of the crowded dance floor.

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The hide, tanned with vegetable juices—since the leather would not last long if tanned by the usual methods—is stretched over the clay and pressed firmly into the wrinkles until it fits as closely as the skin of a living animal. Then a heavy coating of plaster is placed on the outside of the skin, arranged in three sections to form a mold. When this plaster hardens, it is removed with the hide, and all the clay scraped away from the inside, leaving only the skin covered by its heavy coat of plaster. Inside the skin is then built a firm shell, hard as granite, made of layers of wirecloth, papier-mâché and shellac, exactly similar to the original clay statue. Over this the skin is again stretched, the plaster removed—and the stuffed animal appears as real as a living elephant, but light enough to be moved by hand.

For long-haired animals, such as Rocky Mountain sheep, a slightly different method is adopted, since it would be almost impossible to clean the plaster out of the coat if it were poured directly upon the hide. Here the animal is modeled in clay and a coat of plaster placed directly over the clay model. This mold is cut apart in sections, the clay removed, and a permanent model of papier-mâché built up inside. Over this the skin is stretched.

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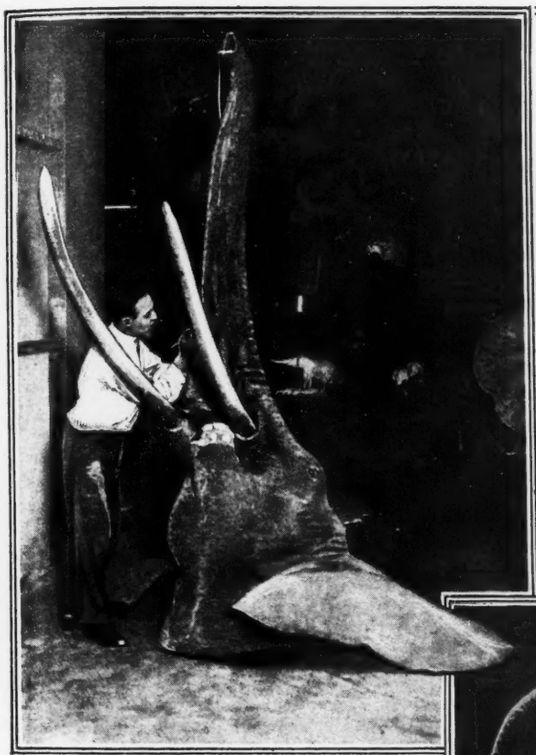

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How skins of wild boars are fitted over mountings of burlap and papier-mâché. The beasts were first modeled in clay

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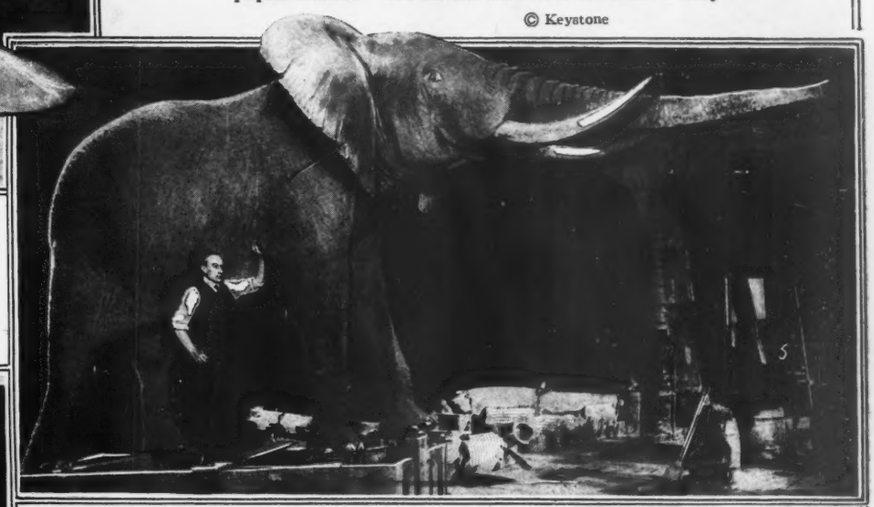

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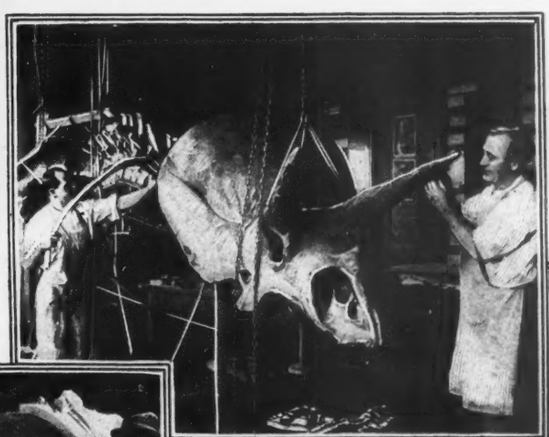

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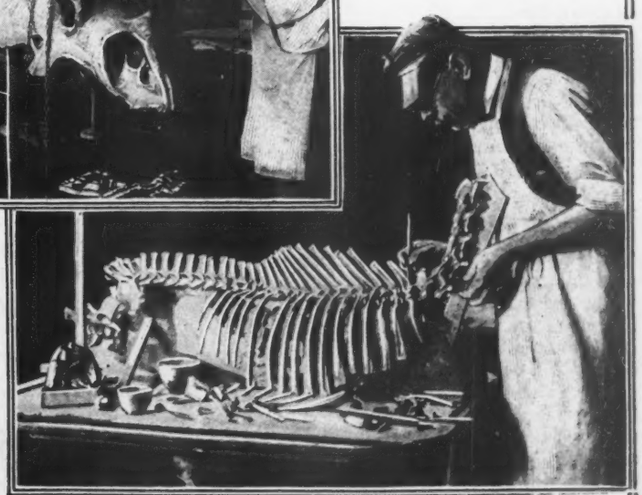

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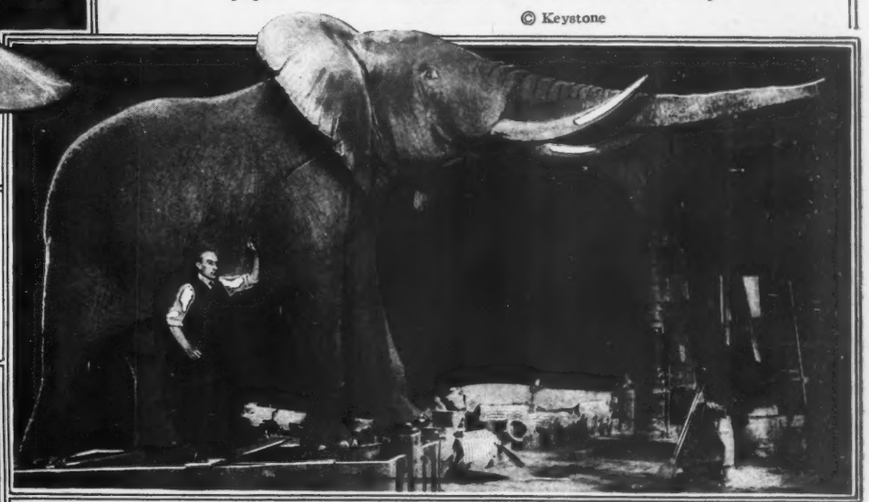

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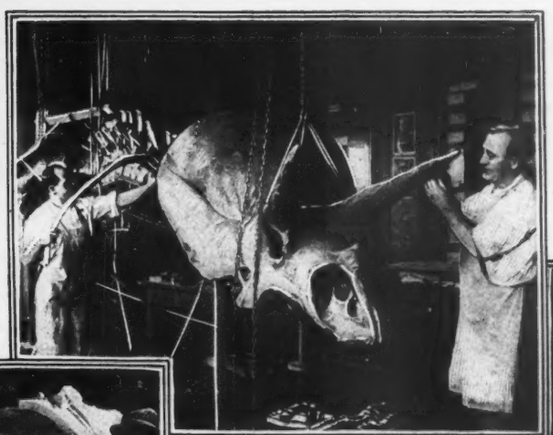

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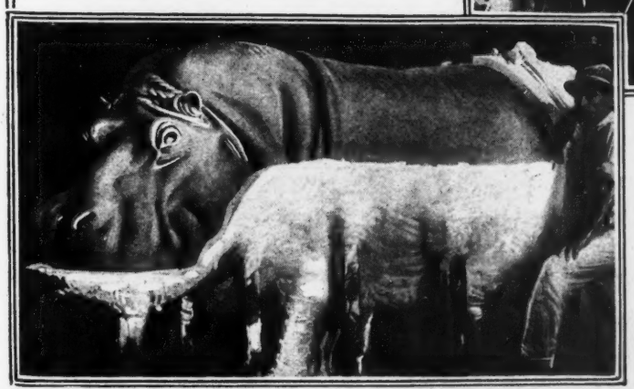

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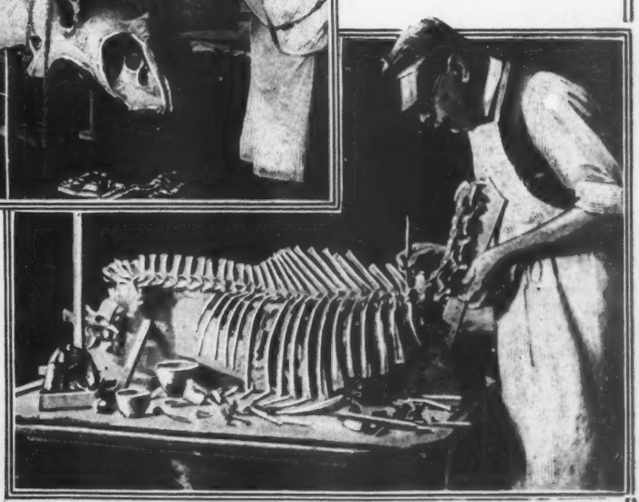

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Harnessed Vibrations Drive Strange New Motor

Power that Razed Walls of Jericho Now Turned to Use by Means of Alternating Current, Vibrating Spring, and Pulley

"So the people shouted when the priests blew with the trumpets: and it came to pass, when the people heard the sound of the trumpet, and the people shouted with a great shout, that the walls fell down flat."—From Biblical account of the fall of Jericho—Joshua VI : 20

HARNESSING a pulley with a web belt attached to a small, rapidly vibrating bar of iron, Leslie R. MacDonald, of Montreal, Canada, claims to have devised a new and remarkably efficient source of power—a motor without armature, commutator, or brushes, and with no rotating parts except for the whirling drive pulley actuated by the vibrating bar.

Recognized by the Ancients

The power of harmonic vibrations has been recognized for ages. There is an ancient story about an old fiddler who had been thrown out of the castle of an angry prince. Sitting down near the moat, the fiddler proceeded to "fiddle down the bridge."

Similarly, according to the Biblical account, the shouts of the multitude of Israelites under Joshua, mingling with the blast of trumpets, brought down the walls of Jericho.

Mr. MacDonald's recent invention of a motor to turn harmonic vibrations to practical use, is due, he says, to an accidental discovery made while repeating a familiar experiment in physics called "Melde's Experiment." In this, a string running horizontally over a pulley is attached at one end to a small weighted pan, while the other end is fastened to a tuning-fork set in motion by an alternating current.

As the fork vibrates, the string, instead of moving back and forth, as one might naturally expect, vibrates up and down with a snakelike whipping motion. Against this vibrating string MacDonald placed a wooden spool slipped onto a screwdriver. The spool revolved rapidly!

Realizing the possibilities of this phenomenon, the inventor arranged to maintain the vibrations of the fork with an electromagnet—and his new motor was born!

The perfected design includes elements for maintaining free vibrations electrically, and a flexible member so tensioned as to allow harmonic waves to be produced in it in such a manner that they perform useful work by turning a pulley.

The motor is a compact arrangement for producing vibration synchronous with the cycle of the alternating current used for power. A heavy vibrating member of laminated iron is pivoted above an electromagnet, with the free end held between two coiled springs, by means of which the rate of vibration can be controlled. Above one end of the vibrating member is a pulley, with a web belt encircling it, and ending in a tension spring fastened to the body of the machine.

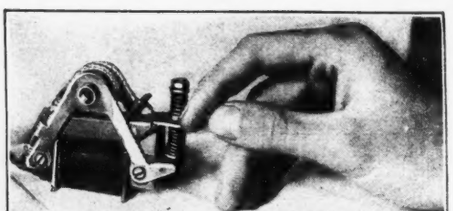
As the magnet pulls down the vibrating member, the spring and belt pull the pulley forward a fraction of a revolution. But when the current is reversed, the polarity of the magnet is changed, and the vibrating member springs back. One would expect this movement to make the belt drag back the pulley, thus neutralizing the gain previously made, but this is not the case. The same whipping action takes place, it is claimed, that occurs in Melde's experiment. The pulley not only holds the previous gain, it is said, but actually seems to move forward a trifle as the belt whips back over it. Thus far, one horsepower is about the maximum developed, but the efficiency is said to be high.

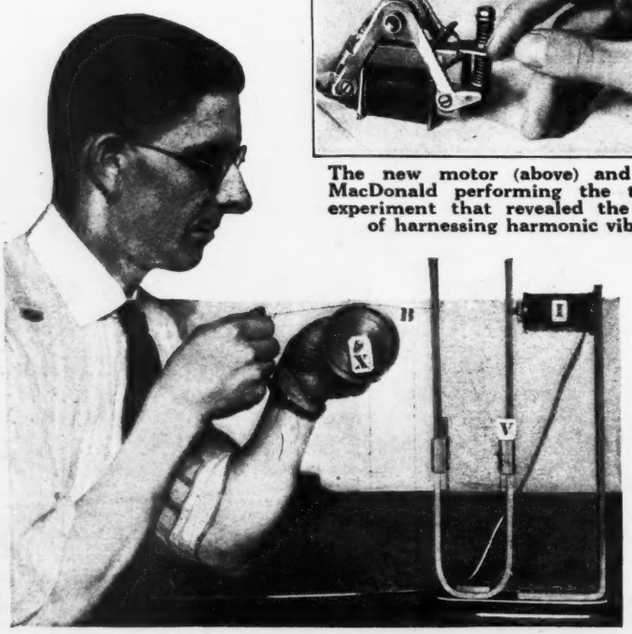
A Slow Speed Machine

The only winding on the new motor is that of a simple, insulated wire coil. No transformer is needed, and it is said to be impossible to burn out the motor, if it is operated on the voltage and frequency for which it is designed. The motor is essentially a slow-speed machine with high starting torque, and can be designed to adjust itself to take care of the load as it increases, thus tending to maintain a speed that is constant.

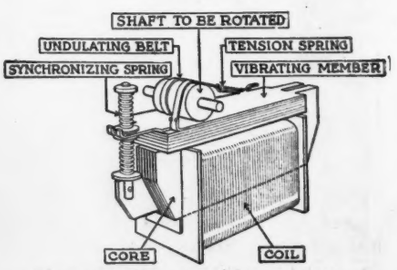
A striking example of its ability to fit into unusual spaces is its possible installation on a sewing machine. For this purpose it is made long and flat, permitting concealment and connection with an outside pulley.

Inasmuch as the new motor has no brushes or other parts to wear out easily, and no bearings to require oil, and because of its simple construction and slow speed of rotation, the inventor predicts practical as well as experimental value for his device.

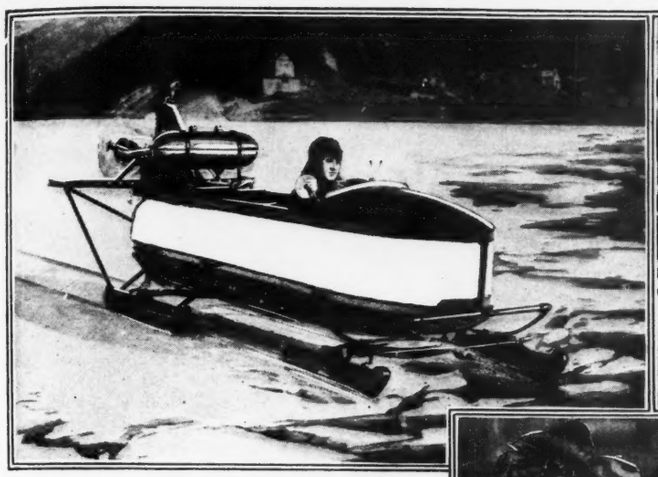




The new motor (above) and Leslie R. MacDonald performing the tuning-fork experiment that revealed the possibility of harnessing harmonic vibrations



How power is derived from vibrations caused by alternating current is described by this diagram of the motor elements



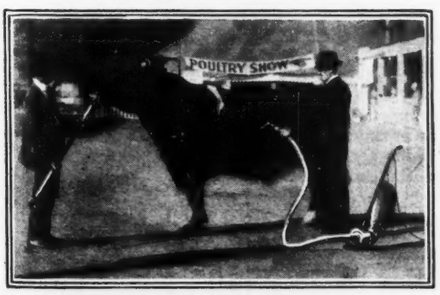
Boat Skims Ice or Water

A SPEEDY air-propelled iceboat designed either to skim over the ice or to cruise in the open water was an innovation for winter sport enthusiasts at St. Moritz, Switzerland, during the last season. The novel machine is a combination sled and motorboat body, equipped with an airplane motor and propeller.

On an icefield the machine has attained a speed of more than 60 miles an hour, carrying three passengers. One of its chief advantages over the ordinary ice-yacht is its stability. It rides on four runners, one at each corner, instead of the long rudder strip and two runners with which the usual iceboat is equipped. Thus the danger of capsizing in a sudden squall or puff of wind is avoided.

A similar boat, constructed by Pierre Proul, of Redbank, outdistanced other ice-craft on the Shrewsbury River, N. J.

Vacuum Grooms Prize Bull



MASSAGING a prize bull with a vacuum cleaner is the latest wrinkle for winning blue ribbons in cattle shows. After an animal has been groomed thoroughly by other methods, the sweeper is said to draw at least a handful of dust.

The appearance of animals is considered so important at these shows that they are not only curried and groomed, but even their horns and hoofs are polished. The bull pictured was a prize winner in all contests, taking first prize in the senior bull class at Waterloo, Iowa, and a blue ribbon at St. Paul, Minn.

Engines Make 25,000 Miles

THE increasing reliability of airplane engines is demonstrated by the astonishing mileage achieved by planes making daily flights between London and Paris. These engines make 10,000 miles before they are overhauled. Several are still in service after having flown 25,000 miles.

© Keystone

Monster Blossoms

GIGANTIC blossoms fashioned of brilliant cambric made their bearers seem diminutive in a recent New York City street pageant. The artificial flowers were made from 10 to 20 times larger than the real blossoms. A poppy was reproduced in a flower that was 20 inches across its petals.

With the flowers as a standard of measurement, spectators could easily imagine that the marchers were fairy people.

Hot Lunch on the Run

ORDERING a quick, hot lunch in Java is no trick if you can catch up with the restaurant, for the quick lunch proprietors travel the streets of Batavia with cookstove, tables, service, napkins, and all, slung over their shoulders.

The meals are said to be well cooked.

Kiddies nowadays loop the loop inside old auto tires

Thrills in a Tire

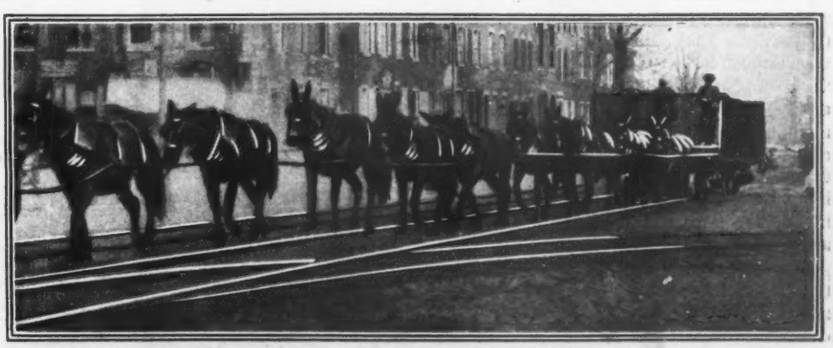
LOOPING the loop in an old auto tire is the latest game, invented by Teddy Ayers, of San Francisco, Calif.

The youngster clings to the inside of the tire, while some grown-up sets the tire on edge and gives it a shove. Carried heels over head a dozen times a second as the tire rolls along, the child loops the loop with as many thrills as he would receive in an elaborate amusement park. The champion looper is said to have made 200 successive loops and yet been able to stand erect at the finish.

Ten-Mule Team Hauls Freight Cars through City Streets

ON account of city ordinances, it is now illegal for railroads owning tracks on Broad Street, Philadelphia, to operate engines over the street. Instead, 10-mule teams pull the cars over the street to a point where the freight can be picked up by a locomotive for its destination.

But until a horse was hitched in the lead of the first team of mules, the driver had constant trouble. Because the horse is more docile and obeys orders, the mules follow the leader without balking.

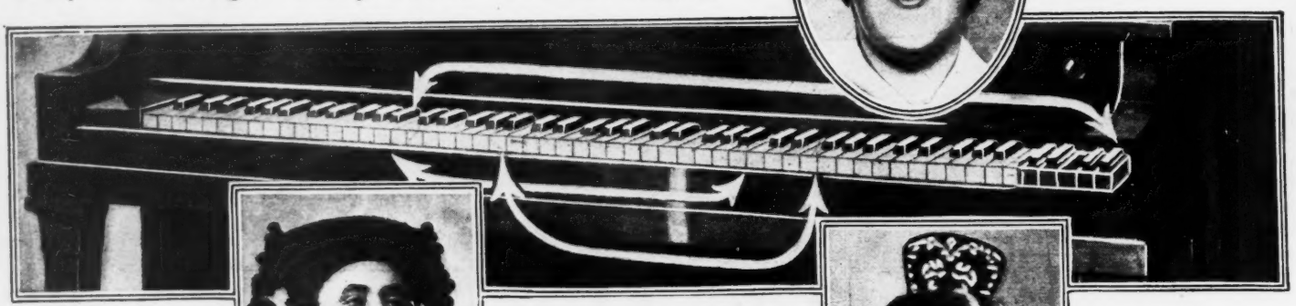


Mule power takes the place of the locomotive in hauling freight cars over tracks on Broad Street, Philadelphia, where ordinances prohibit steam engines

Boy's Voice Climbs Above Piano's Highest Note

Super-Range Surpasses the Greatest

Murray singing the highest note ever reached by human voice. His range is nearly six octaves —from C below middle C to A above the piano keyboard



The three-octave range of José Mardones, noted basso, is considered extraordinary; yet he sings only one tone lower than Robert Murray

Galli-Curci's voice ranges over 2½ octaves —from low B flat to high F. Robert sings two octaves higher

THE highest tone ever sung by a human voice is more than half an octave above the upper limit of a piano keyboard and more than two octaves higher than Galli-Curci's highest! It is so high, in fact, that a testing whistle is required to determine just how high it is.

This tone comes from the marvelous throat of Robert Murray, a 12-year-old boy, whose training before he began the study of music in New York City, consisted of imitating the melodious notes of birds at his home in Tacoma, Washington.

In recent tests the boy far outdistanced his accompanist, reaching the A above the highest C on the piano. This is a world's record—12 full tones above the highest ever sung before, and two and one half octaves above the so-called "high C" that is the goal of the operatic tenor. The low limit of his voice is the C below middle C—or only one full tone higher than the lowest note of José Mardones, basso of remarkable range.

Thus the full range of Robert's voice is nearly six octaves!

Almost as remarkable is the fact that through modern scientific training, the voice probably will be preserved through adolescence. After scientific study of the boy's throat, Dr. Frank E. Miller, New York throat specialist, predicts that the voice almost certainly will be a tenor. By a method entirely new in vocal training, scientists expect to place the voice before the change comes, thus overcoming the usual break.

Doctor Miller compares the act of singing to the playing of a cornet, in which the player produces the sound by varying the shape of his lips as he blows into the mouthpiece. He can still further change the pitch of a note by means of keys manipulated with his fingers, the action of the keys being to change the length of the vibrating column of air in the winding brass tube.

In the larynx, says Doctor Miller, the vocal cords correspond to the lips of the cornet player, since both are set in vibration by the air driven up by the lungs. Similarly, the twistings and windings of the cornet tube correspond to the cavities in the mouth and nose, which if placed end to end would extend over many feet. Finally, the shapes of the various mouth and nasal cavities can be altered at the will of the singer, thus producing the same result that the cornet player accomplishes by means of his keys. It has been demonstrated that the larynx alone is capable of 16,000 adjustments and readjustments of shape affecting voice production.

According to Doctor Miller, Robert Murray's vocal cords are exceptionally strong, elastic, and flexible—thus enabling him to shorten them to a remarkable degree for the production of very high notes—and his resonance cavities are far better adapted for perfect singing than the average. In addition, the boy possesses rare musicianship, memory, and interpretive ability. The apparatus—called the Galton whistle—used in testing the upper limit of Robert's voice, consists of a small-bore piston whistle attached to a rubber bulb. The pitch is regulated by means of a screw cap on the top, each turn of the screw raising the pitch half a tone.

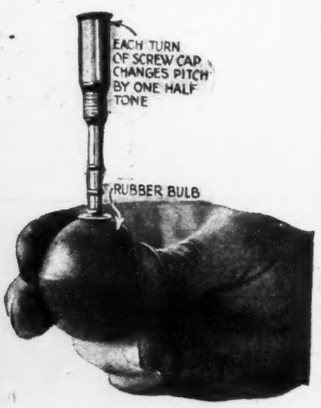
The test was made in clear, bright weather, since Robert's voice, like those of other singers, varies slightly with changes in atmospheric conditions. He is able to reach a higher note when the humidity is low and the barometer high.

The highest note ever reached heretofore was attained by a woman, according to the testimony of the celebrated composer, Mozart. More than 100 years ago, Lucretia Agujari sang three octaves above middle C, yet Robert Murray's high note is almost *five* octaves above middle C, an unpreeedented range.

Can Your Child Become a Great Singer?

HERE are four important tests applied by experts in determining whether a child has an unusual voice:

1. Range. More than two octaves —the average range for children's voices—is exceptional.
2. Quality of tone. Most untrained voices possess not more than four or five good, clear tones.
3. Resonance. A singing voice must possess carrying quality at the outset if it is to fill a concert hall.
4. Musical ear—a quality that is all important.

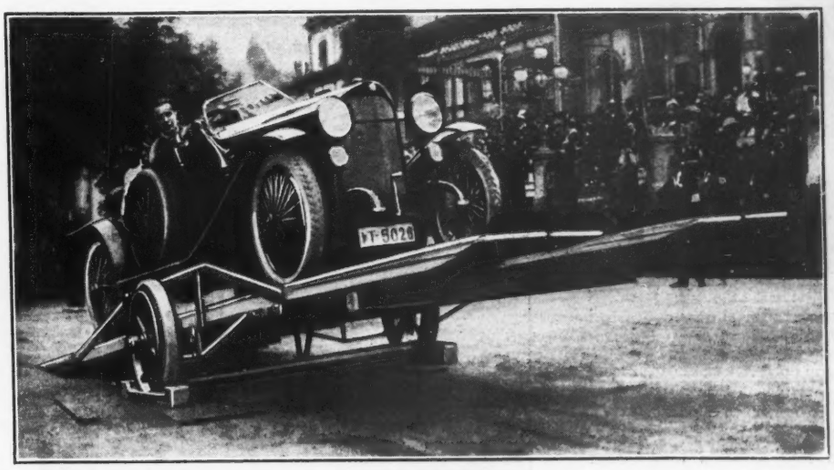


Upper limits of Robert Murray's voice are tested with a Galton whistle, illustrated above. The pitch of the whistle is regulated by a screw cap

Can You Teeter Your Auto on the Center of a "Seesaw"?

ODD tests of driving skill were a feature of automobile games recently held for amateur drivers. To test the exactitude with which a car could be controlled, for example, a large seesaw was mounted on truck wheels in the center of the street. Each contesting driver was required to drive up one side and stop in the center in such a way that by balancing in his seat, he could "teeter" with his car.

Though the feat is seemingly almost impossible—for few drivers ever know, or need to know, the location of the center of gravity in their cars—several of the contestants are reported to have succeeded in achieving it.



Keep Blossoms Fresh in a Potato Vase

POTATOES are excellent receptacles for the stems of cut flowers, permitting the arrangement of bouquets in ways that often cannot be obtained with the usual china flower-holders. The holes to receive the stems may be bored in the potato with the point of a paring-knife. It is claimed, although upon what grounds it is not known, that if the stems of cut flowers are placed in a potato, they will remain fresh longer than those kept in water.

Place the stems of the blossoms in holes bored in the potato

Load on Each Car Wheel Can Be Measured

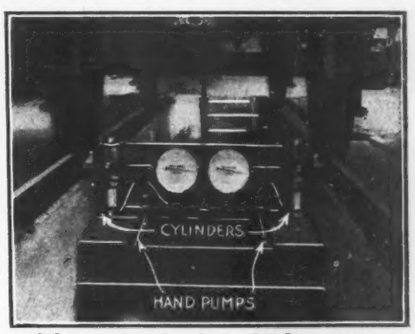
DESIGNERS of European railroad rolling stock are now able to measure the load of engines and freight cars on the rails, and to determine whether each wheel is bearing its share of the weight. The machine that thus can weigh a locomotive a wheel at a time was recently perfected.

It consists of two parts—the weighing mechanism proper and a strongly braced carriage for moving it about in the pits under the cars. The cars themselves are not moved during the weighing, as it is easier to move the scale.

The weighing apparatus consists of two oil presses with the pistons so accurately fitted in the cylinders that no packing is necessary. The motion of the piston is therefore frictionless for practical purposes; hence the oil pressure in the cylinders accurately measures the load on the piston top.

Both pistons are attached to a single crosshead, fitted with projecting lugs that engage the flanges of the wheels.

The pistons are connected with a hand pump, which raises the crossbeam and the car. When the wheels are clear of the track, the pressure shown on the gages is taken to be the weight on the wheels.

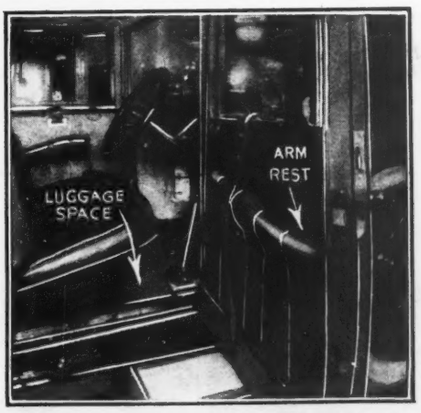


Oil pressure in the cylinders measures the load when hand pumps raise the wheel

Universal Locknut Makes Bolts from Scrapheap

A UNIVERSAL locknut that will hold on unthreaded bolts has been patented by J. A. Wheeler, of Bloomington, California. It consists of a concave piece of steel like a heavy washer, with the hole threaded and split by four radiating saw-cuts. When this nut is hammered flat, the jaws will grip with great force the smooth iron bolt. The threads of the nut are of special design, being shaped like the teeth of a saw.

Jaws grip the smooth bar



Driver Has Arm Rest in New Limousine

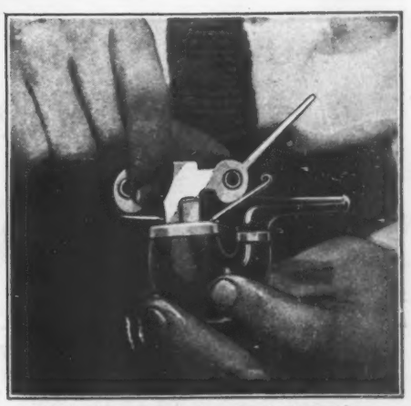
AN arm rest for the driver on the inside of the auto door, is one of the conveniences of a limousine recently completed by an American builder of custom bodies. The chauffeur's elbow rests comfortably on a cushion attached to the door frame.

Another simple convenience has been achieved in the body by leaving a space about eight inches deep under the front seats. This provides room for umbrellas or parcels.

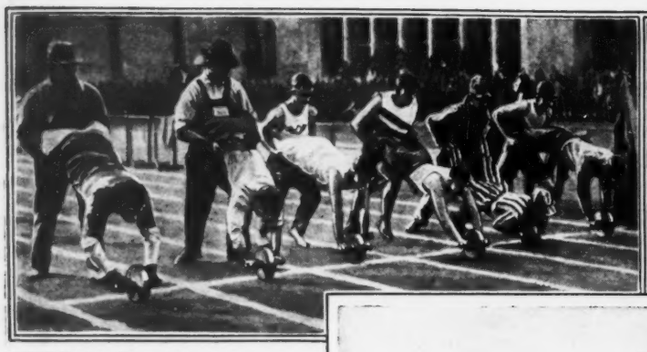
Combination Tool Cleans Pipe-Bowl and Stem

FOUR cutting-blades, like two knives mounted back to back, make short work of the "cake" in a pipe. The novelty cleaner also has a long stem-reamer that will remove all obstructions from the pipe-stem. When not in use, the reamer folds across the top of the cutter.

The pipe shown below is made for automobilists. It is provided with a hinged metal cover.



Blades to cut the "cake" and a reamer to clean the stem



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Courtesy Paramount Pictures

BEES WILL NOT STING while they are swarming, and will alight on almost any object. To demonstrate this, the veteran beekeeper shown below offered his chin to a swarm and several thousand bees affixed themselves to his face. To induce the swarm to gather, the queen bee was placed in a little wire cage under the keeper's chin

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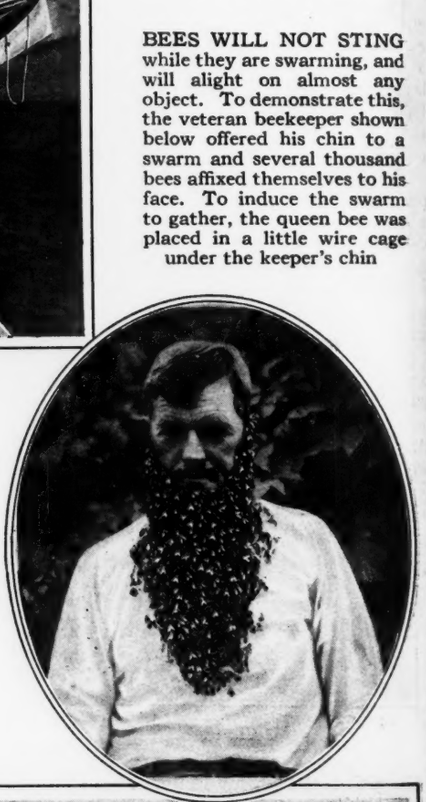
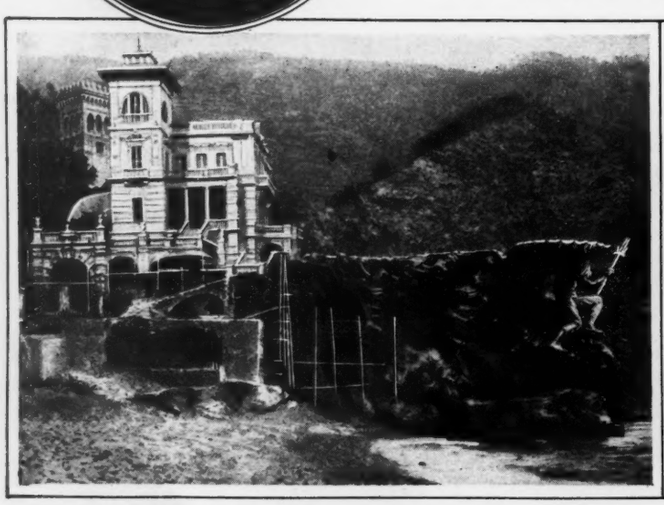
The actors, wearing life preservers, group themselves at the stern of the barge and at the director's command rush to the decks and stage their thrilling battle for places in the lifeboats





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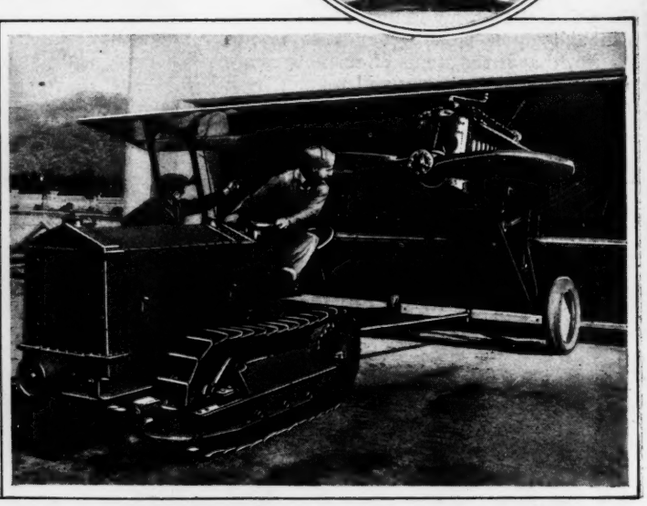


ROLLING AIRPLANES INTO THEIR HANGARS has been simplified by the use of a small tractor and dolly. By employing a straight towbar with a toggle joint at each end, the driver of the tractor can guide the plane without assistance

Army Bombards Goats with Gas in Safety Tests

HOW much gas does it take to kill a man?

At the Lakehurst, N. J., proving grounds, army officers are continually conducting tests to find out by gassing, not men—but goats.

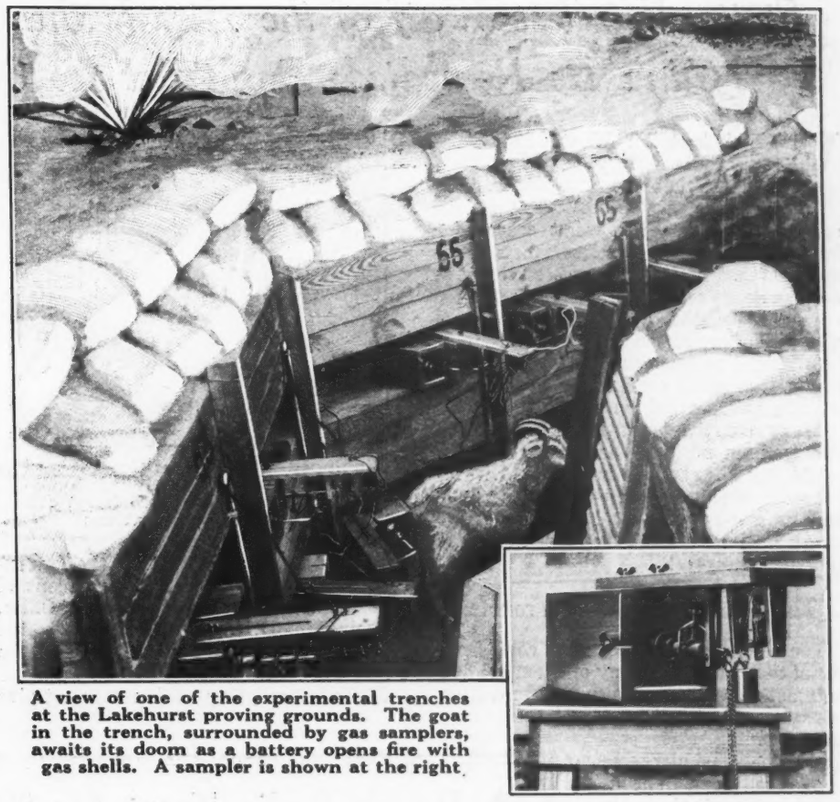
The chief reason for these tests is the increasing use of poison gas in peacetime. Already gas is being employed on a small scale to exterminate the boll weevil and other insect pests, as well as to destroy rats and vermin. And were it not for the danger of killing human beings, still more important results might be achieved. Thus, accurate knowledge of exactly what concentration of gas is harmful to man is of great practical importance.

Batteries Shell Trenches

In making the tests, gas is liberated either from containers, in clouds, or by the explosion of gas shells fired from a battery at trenches that imitate conditions in the late war. The effect of the fire is judged both by the behavior of goats tethered in the trenches, and by analyzing the gas collected later in automatic gas samplers.

The sampler consists of a glass bottle placed inside a wooden box, the sides of which are about an inch thick. After a vacuum has been created in the bottle, the neck of it is closed by a rubber stopper penetrated by a short section of rubber tubing that ends in a thin glass tube sealed with a metal stopper.

To the stopper is fastened a chain and a heavy lead weight. When the sampler is placed in the trench, the weight is held up in a swinging hook that can be released by closing the circuit of an electromagnet on a wooden arm fastened to the container. A pinchcock on the rubber tube closes the bottle after the gas has been admitted.

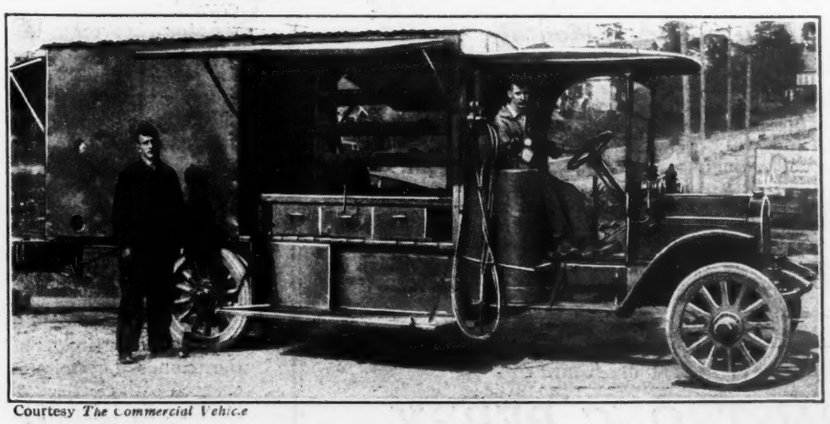


A view of one of the experimental trenches at the Lakehurst proving grounds. The goat in the trench, surrounded by gas samplers, awaits its doom as a battery opens fire with gas shells. A sampler is shown at the right

When the trenches are shelled, flying shell fragments break the glass tubes, which are in exposed places. The air, laden with the poison gas, rushes in to fill the vacuum in the bottle. By analyzing the contents of the bottle later, observers in a near-by steel tower can determine the exact density of the gas in the trench. In addition, the effect is judged by autopsies on goats tethered near by.

However, since not all the glass tubes are broken at the conclusion of the fire, the observers close a series of switches that energize the electromagnets. The heavy load weights fall and pull the stoppers from the bottles.

Traveling Machine Shop Repairs Trucks on the Road



Courtesy *The Commercial Vehicle*

By ingenious arrangement of full repair equipment and drawers for small tools and parts, this traveling power plant and repair shop is equipped for any emergency

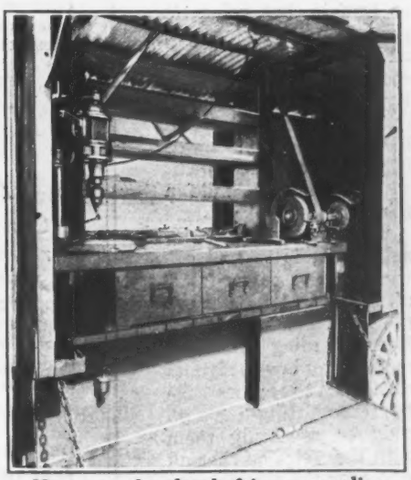
HOW is a man to keep his auto trucks in repair when they are out in the country districts, far from a garage, for days at a time, as is the case in road construction work?

One successful way is to carry the repair shop with the trucks. A Pacific Coast paving firm, for example, has converted an old truck into a completely equipped portable garage by installing a special body and a compact mechanical outfit equipped to handle a majority of the repairs that would usually have to go to the machine shop.

Power from the driveshaft is carried by an overhead shaft, belt, and pulley to the rear of the truck, where it operates an air compressor that will inflate tires, do painting, or operate a riveting hammer. On the same shaft is a three kilowatt electric generator that drives a tool grinder, a drill press, and a forge blower for the collapsible blacksmith's forge.

To carry the complete outfit of tools in such a small space, ingenious arrangements have been adopted for utilizing every inch of space inside the body. From the photographs it will be seen that the sides of the truck can be let down, and that the mechanics stand upon these extensions while working at the bench.

A complete electric lighting system makes it possible for the mechanics to do emergency work at night.



How overhead shafting supplies power for the machine is shown in this close-up of the repair bench

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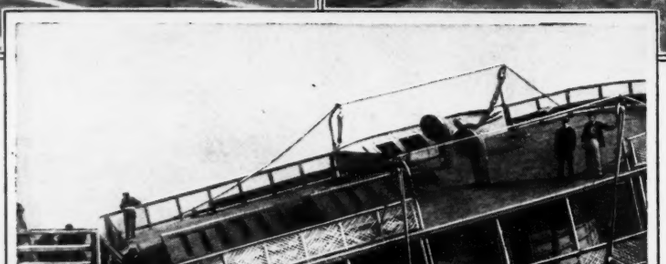

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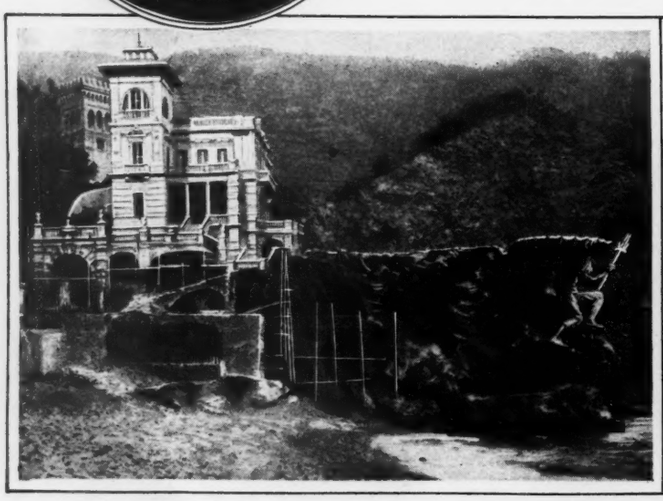

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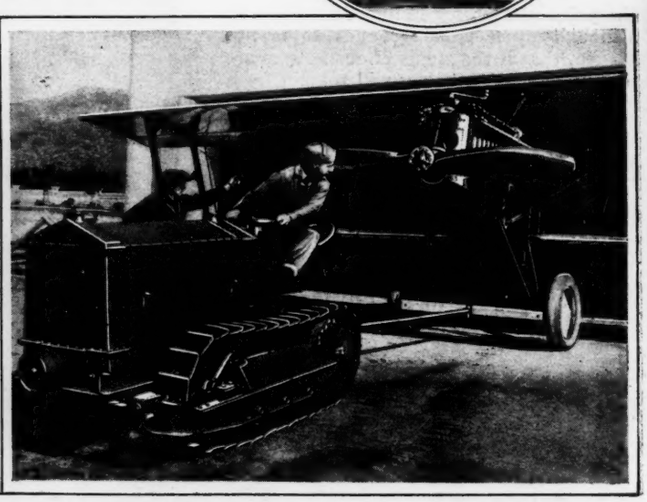

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Army Bombards Goats with Gas in Safety Tests

HOW much gas does it take to kill a man?

At the Lakehurst, N. J., proving grounds, army officers are continually conducting tests to find out by gassing, not men—but goats.

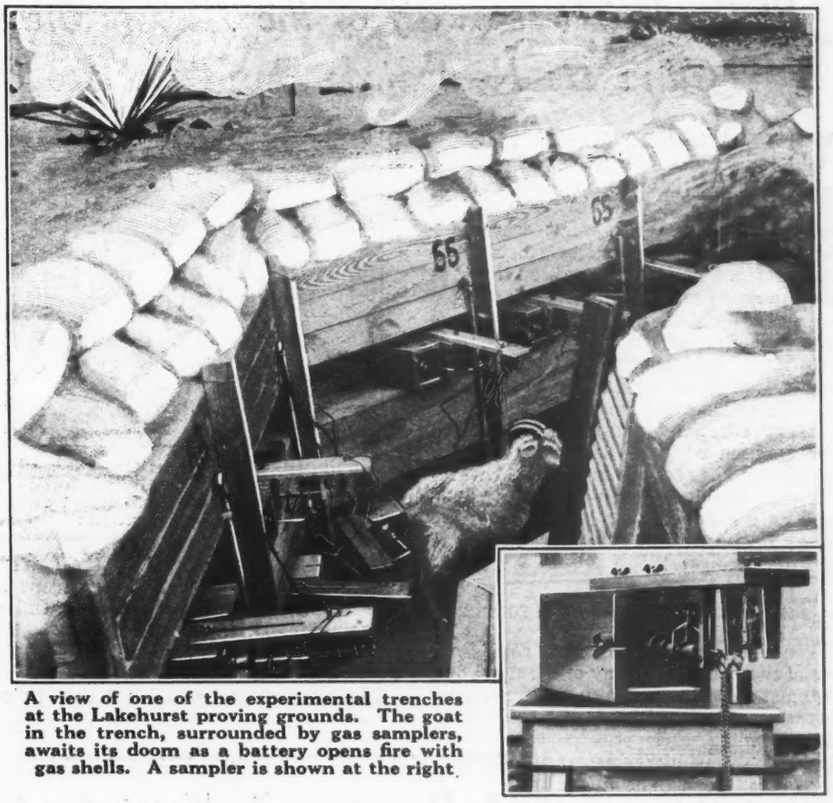
The chief reason for these tests is the increasing use of poison gas in peacetime. Already gas is being employed on a small scale to exterminate the boll weevil and other insect pests, as well as to destroy rats and vermin. And were it not for the danger of killing human beings, still more important results might be achieved. Thus, accurate knowledge of exactly what concentration of gas is harmful to man is of great practical importance.

Batteries Shell Trenches

In making the tests, gas is liberated either from containers, in clouds, or by the explosion of gas shells fired from a battery at trenches that imitate conditions in the late war. The effect of the fire is judged both by the behavior of goats tethered in the trenches, and by analyzing the gas collected later in automatic gas samplers.

The sampler consists of a glass bottle placed inside a wooden box, the sides of which are about an inch thick. After a vacuum has been created in the bottle, the neck of it is closed by a rubber stopper penetrated by a short section of rubber tubing that ends in a thin glass tube sealed with a metal stopper.

To the stopper is fastened a chain and a heavy lead weight. When the sampler is placed in the trench, the weight is held up in a swinging hook that can be released by closing the circuit of an electromagnet on a wooden arm fastened to the container. A pinchcock on the rubber tube closes the bottle after the gas has been admitted.

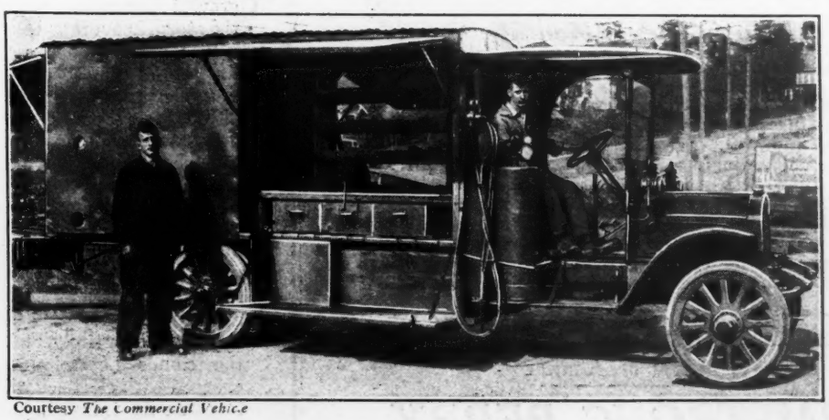


A view of one of the experimental trenches at the Lakehurst proving grounds. The goat in the trench, surrounded by gas samplers, awaits its doom as a battery opens fire with gas shells. A sampler is shown at the right

When the trenches are shelled, flying shell fragments break the glass tubes, which are in exposed places. The air, laden with the poison gas, rushes in to fill the vacuum in the bottle. By analyzing the contents of the bottle later, observers in a near-by steel tower can determine the exact density of the gas in the trench. In addition, the effect is judged by autopsies on goats tethered near by.

However, since not all the glass tubes are broken at the conclusion of the fire, the observers close a series of switches that energize the electromagnets. The heavy load weights fall and pull the stoppers from the bottles.

Traveling Machine Shop Repairs Trucks on the Road



Courtesy *The Commercial Vehicle*

By ingenious arrangement of full repair equipment and drawers for small tools and parts, this traveling power plant and repair shop is equipped for any emergency

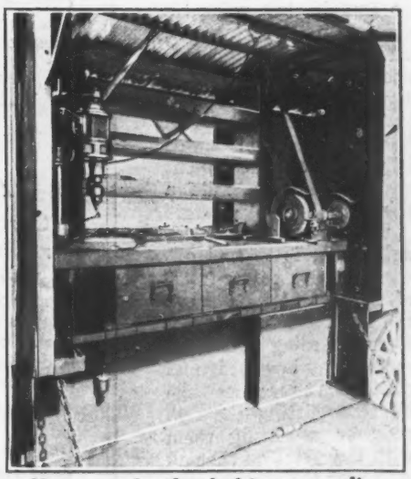
HOW is a man to keep his auto trucks in repair when they are out in the country districts, far from a garage, for days at a time, as is the case in road construction work?

One successful way is to carry the repair shop with the trucks. A Pacific Coast paving firm, for example, has converted an old truck into a completely equipped portable garage by installing a special body and a compact mechanical outfit equipped to handle a majority of the repairs that would usually have to go to the machine shop.

Power from the driveshaft is carried by an overhead shaft, belt, and pulley to the rear of the truck, where it operates an air compressor that will inflate tires, do painting, or operate a riveting hammer. On the same shaft is a three kilowatt electric generator that drives a tool grinder, a drill press, and a forge blower for the collapsible blacksmith's forge.

To carry the complete outfit of tools in such a small space, ingenious arrangements have been adopted for utilizing every inch of space inside the body. From the photographs it will be seen that the sides of the truck can be let down, and that the mechanics stand upon these extensions while working at the bench.

A complete electric lighting system makes it possible for the mechanics to do emergency work at night.



How overhead shafting supplies power for the machine is shown in this close-up of the repair bench

What Makes the Noises that Mar Radio Concerts?

Static, Wireless Waif of the Air, Is the Only Interference that Can't Be Remedied; Don't Let the Others Worry You

WHAT is static? What will it do to my radio set? What other kinds of interferences will bother me?"

These are typical questions that are asked as summer—the worst season for interferences with wireless messages—approaches. Stations interested only in code work are seldom seriously affected for any great lengths of time, but amateurs whose chief recreation is the picking up of broadcasted concerts and lectures are liable to be interrupted continually by series of strange, unaccountable noises.

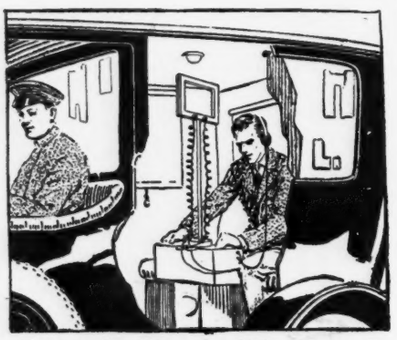
Many complaints of interference have already been made by new users of radio receivers. They tune in as usual and everything is working well when suddenly—bang! gr-r-r—whee-e-e-! somebody or something butts in and they lose the music and their tempers!

Two Main Sources of Trouble

These radio interferences may come from one of two sources. Many of them are due to amateurs with powerful regenerative sets who operate without understanding their stations. The remainder come from the most uncontrollable force in the radio universe—static.

The real cause of the trouble can usually be discovered by an experienced radio man, but the blame should not be attached to any one until it is definitely located. In a locality where there are many transmitting stations, signals from them may break up a concert. The allotment of different wave lengths to their respective classes of transmitting stations theoretically permits the concert and various messages to go out at the same time with as little interference as three trains would create for each other if they were all en route from New York to Buffalo, but going *via* the Erie, Lackawanna, and New York Central respectively. In practice, however, collisions occur in the receiver that sound like the three trains meeting at a common point while running a mile a minute.

The remedy, when signals clash, is to find out where they come from, after all efforts to tune out the intruders have failed. Every sending station is required by law to sign its call letters to each message by transmitting them in code or repeating them with the voice so that all who hear the station may identify it. By using the lists of stations published by the government and sold by the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 cents each, the location of a station and the name of the owner can be learned.



Equipped with a sensitive set and loop antenna, a "detective" automobile has been employed to ferret out interfering radio stations

If the interrupting station does not give its call letters, the district radio inspector may be asked to focus direction finders on it and bring the owner to justice, but he should not be bothered unless a station is clearly violating the law.

How Disturbers Are Detected

Many interesting methods have been devised to ferret out interfering stations. Most of them include the loop aerial because of its directional properties. The work can be carried out from official stations, but for heavily populated districts a scouting automobile equipped with a sensitive set and a loop antenna has been employed in tracking down the culprits.

A very efficient receiver will also bring in all sorts of hums and buzzes from electric light and power lines, trolley car motors, and automobile magnetos. Violet ray apparatus may be heard at work in neighboring boudoirs, as may X-rays boring their paths into troubled human interiors, and lightning-rod agents producing miniature electric storms. An antenna that runs parallel to wires near by will pick up current from them and produce noises in the receiver, but if it is at right angles to near-by wires there will be little trouble unless it happens to touch one.

The worst disturber of the ether is "static." Listen in while a thunderstorm is approaching and at the same time watch with the eyes for the lightning flashes. Do not watch too long! Pull the lightning switch and ground the aerial before the storm is overhead.

The instant you see the flash you hear a grumble, growl, or crash in the telephone. This seems to prove the assertion of the scientists that radio and light waves travel at the same rate of speed.

Static is worse in the summer than at other seasons, though it may occur at any season. It does not depend entirely upon the clouds becoming so charged with electricity as to cause lightning. Some old-time radio amateurs used to give up the game during the hot weather, declaring that the shortened range and the static interference took all the joy out of it. But to-day many a listener continues to enjoy his favorite indoor sport the year round, for he can hear something all the time and, more than that, he can hear what he wants to hear most of the time.

A Double Radio Treat for "Popular Science" Readers

The Man Who First Awakened the World to the Future of Radio

JACK BINNS

whose historic "CQD" call from the steamship *Republic*, on January 23, 1909, saved 1650 lives in what was the first and remains the most spectacular wireless rescue at sea

Writes His Magazine Articles Exclusively for "Popular Science Monthly."

Read the first radio article by Jack Binns in our June issue.

WHEN JACK BINNS sent out from the sinking *Republic* the first wireless call in a disaster at sea, putting on every tongue that thrilling signal, "CQD," (now "SOS") and making two continents ring with his exploit, he unknowingly forecast the myriad marvels of radio today. Jack Binns was one of the first commercial wireless operators; he has kept abreast of the subject ever since, and besides that, he is a trained journalist, a newspaper writer of many years' experience—a man whose style is vivid, direct, and enjoyable. His exclusive radio articles will appear next month and every month in these columns. You will find help and inspiration in his radio tips.

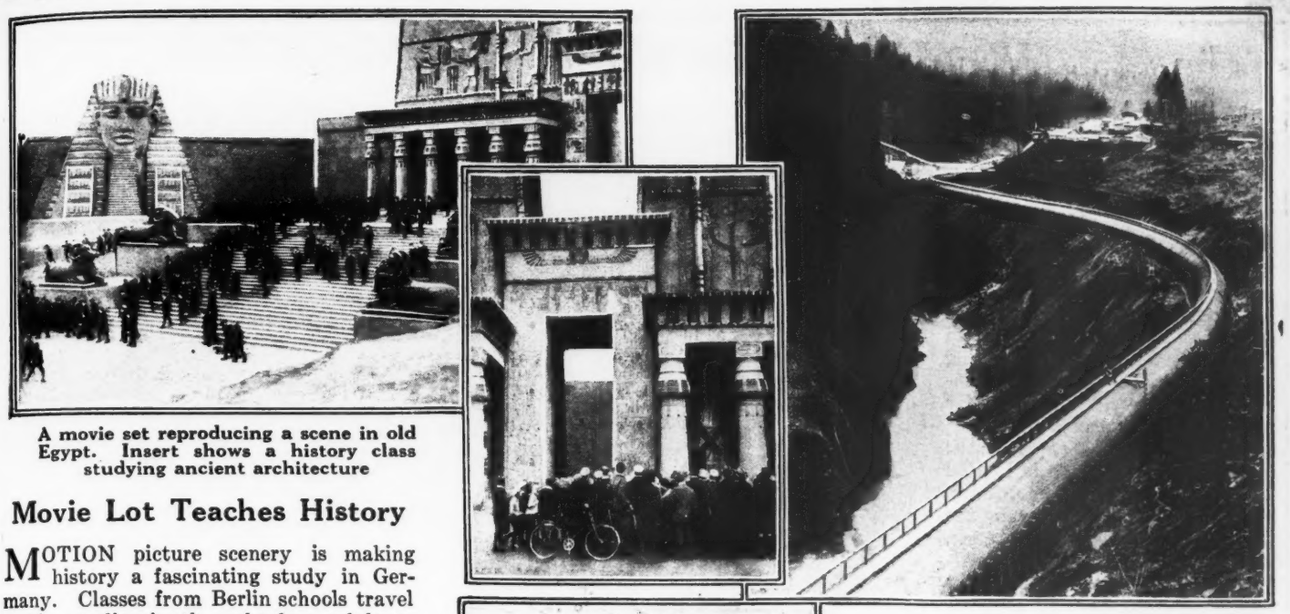
The Man Who First Aroused America to the Romance of Radio

ARMSTRONG PERRY

Continues to write his epoch-making series of radio articles for "Popular Science Monthly"

ARMSTRONG PERRY'S FIRST great radio article appeared in *Popular Science Monthly* for November last. The phenomenal radio-telephone boom—unborn a month before—sprang into being within the following fortnight. Month by month, as Mr. Perry pressed his story home through our columns, radio became the great economic, industrial and social event of the year.

Between them, these two men are the nation's best known writers on the most engrossing subject of the decade. Don't miss them next month.



A movie set reproducing a scene in old Egypt. Insert shows a history class studying ancient architecture

Movie Lot Teaches History

MOTION picture scenery is making history a fascinating study in Germany. Classes from Berlin schools travel to the studios in the suburbs, and here, by examining the "sets" constructed for feature pictures of ancient times, learn how the ancient Romans and Egyptians built their homes and monuments.

These buildings are accurate copies of the ancient originals even to the colors of the paint and the smallest detail of design.

The classes learn as much by their visits as they would during a tour of Memphis, Rome, or other places being portrayed.

To Turn Trash into Power

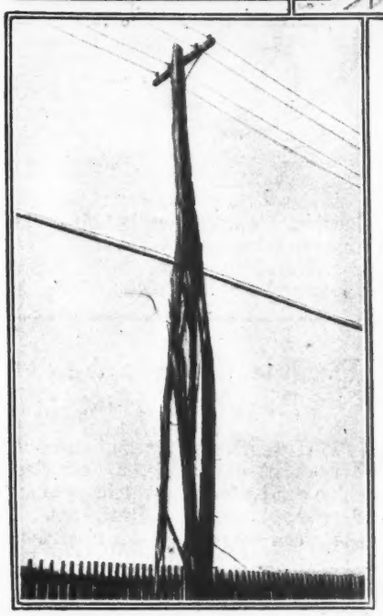
IN Tokyo, Japan, authorities are planning to use trash and waste of the city, estimated at 1000 tons a day, as fuel in large electric generating plants. It is believed that 6000 kilowatts could be obtained by the use of this fuel.

Camouflage for Hunters

CAMOUFLAGED suits will deceive ducks as well as enemy soldiers. This discovery was made by several hunters, who dressed in suits covered by tufts of grass and so managed to bag all the law allows.

It is important, they found, that the suit conceal the lines of the human figure. If this is done, and if colors that blend with the landscape are chosen, it is not necessary that the suit resemble any natural object.

If the gun barrel also is camouflaged, still better results can be obtained, since birds seem to be more afraid of weapons than of man.



Shattered Pole Stands

WITH its center shattered by a bolt of lightning that ripped a large hole in the earth at its base, a telegraph pole at Mineola, L. I., is still standing. Some strange freak of the lightning saved the pole from being cut in two. The top and bottom were not damaged.

Apparently the lightning was attracted by the iron spikes in the pole, and then passed through the heart of the pole.

Wood Pipe Wide as Tunnel

A WOODEN stave pipe, 13 feet 6 inches in diameter, and said to be the largest in the world, conveys water from the White Salmon River to a hydroelectric plant near Portland, Ore.

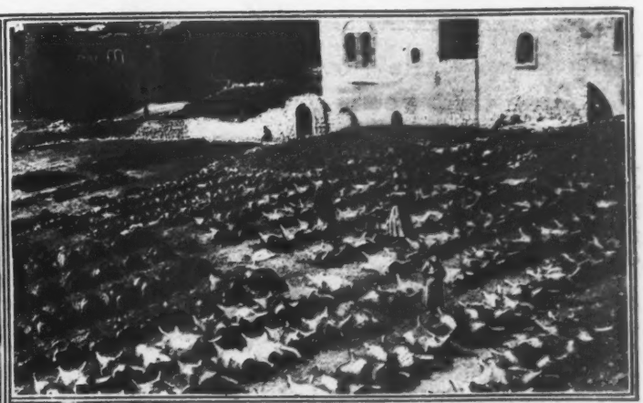
The conduit is built of staves of Douglas fir, like an elongated barrel, and is held in shape by hoops of iron rods. These are placed about six inches apart to give exceptional strength, since a very large head of water is carried, and pressure on the interior is consequently tremendous.

Wood is used instead of iron because it is not affected by extremes of heat and cold. An exposed pipe built of iron would expand and contract as the temperature varied, and cracks and leaks would soon develop. A further advantage of wood is the fact that it is free of scale. The inside will remain clean and smooth almost indefinitely. Strangely enough, wood used in pipes does not rot readily. While stave pipes are expensive to build and install, they are said to have a far longer life than iron.

Big Market for Goatskins

GOATSKIN is the favorite material for water bottles in the Orient. At the world famous market at Hebron, in Palestine, thousands of these bottles are sold every year. The process of manufacture at the tanneries is long and complicated, for the tanner will often spend a week upon a single skin to make it watertight.

Dressed in a canvas suit tufted with grass, the hunter deceives the wisest ducks. This camouflage blends the human figure into the landscape



Here, in the water bottle market at Hebron, Palestine, 300 goatskins, inflated to prove they are watertight, are awaiting purchasers

The Man Who Flooded the World with Printed Knowledge

[The story of Ottmar Mergenthaler, who among *Popular Science Monthly's* greatest contemporaries was perhaps the poorest business man, but the wizard mechanic.]

IF Ottmar Mergenthaler, journeyman watchmaker, had not slipped away from his native Württemberg to avoid military service; and if J. O. Clephane had been content to be the best shorthand reporter in Washington, instead of cherishing the delusion that he was an inventor, the world would be far more benighted than it now is.

Figure it out for yourself: progress in civilization is limited by the diffusion of knowledge, which is chiefly dependent on the art of printing, which, in turn, devolves largely upon the handicraft of typesetting. For 400 years there had been no advance in typesetting until Clephane prodded Mergenthaler into inventing the linotype, which struck the shackles from the printing art and thus let loose a flood of knowledge.

Ottmar Mergenthaler and the linotype machine which he perfected

Before the clatter of the typewriter came, Clephane almost invented a machine to reproduce his notes instead of writing them out in longhand. His idea was to print on a sheet of paper, which was to be reproduced by lithography. He employed a near machinist to develop his idea, then sent the machine to the watchmaker, Mergenthaler, in 1876, to find out why the thing wouldn't work. Mergenthaler, then 22 years old, found the design wrong and the construction worse. On order, he built a machine that would print, but the copy couldn't be lithographed. A machine to make type impressions in papier-mâché as a matrix from which to make stereotypes was equally unsuccessful.

After puttering along until 1883, Mergenthaler built a machine to cast metal into type bars into which matrices had been stamped. In July, 1884, he cast the first linotype slug. The second linotype with automatic justifier in February, 1885, won congratulations from President Arthur, J. G. Blaine, and other distinguished men. The first linotype ever installed in a newspaper office was placed in the New York *Tribune* composing-room in July, 1886.

The linotype was still far from perfect. Mechanical, manufacturing, and business difficulties were great. Being a poor business man Mergenthaler almost lost the results of his years of labor. Fourteen years later a greatly improved machine was introduced. Ten years more were required to complete the introduction of the linotype.

Since then the linotype has been steadily developed until now it handles all the composition required in a newspaper office. More than 60 fonts are available.

Hens Supply the Power for Machine that Feeds Them

A NEW machine that feeds and exercises poultry derives power for its operation from the hens themselves. Operation is effected by means of a swinging baitbar filled with bright-colored grain like yellow corn to induce the hens to peck at it.

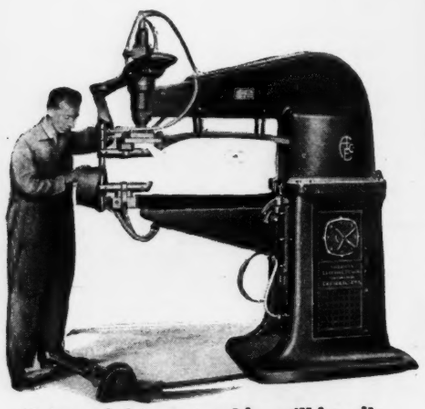
Set in motion, this bar revolves a circular casting inside the can. Prongs on the casting sweep the grain through three holes of adjustable diameter. The grain falls on a cone-shaped apron and bounces into the henyard, keeping the fowls busy picking it up.

The inventor of the device declares that in a few minutes hens learn the trick of picking at the swinging baitbar.

Flexible Electric Welder Regulates Heat

WITH welding points that can handle work at any angle, a new electric machine can perform spot welding of every kind without special adjustments. The operator can concentrate his attention on the spots he is welding, for the entire process is mechanical.

The machine is of the box type of construction, so that the workman is protected against accident. It can be operated either by hand or foot, or by both, without disconnecting either one of the operating levers.



Points of this spot welder will handle work at any angle

A heat regulator provides eight temperatures for welding material, from No. 30 gage to pieces of 5/16-inch stock.

A NEW pest, called "blister rusts," threatens to destroy our forests of white pine.

Compressed Air Does Work of Engine "Wipers"

COMPRESSED air cleaners in the locomotive roundhouses of the Santa Fé Railroad are now performing the work of oilers who formerly wiped off engines by hand with pieces of oily waste.

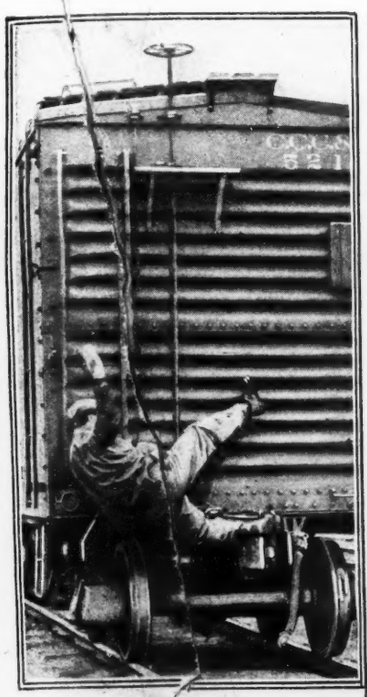
The new apparatus, which will clean a locomotive within a few minutes after it has finished its run, consists of a reservoir filled with distillate and hot water. These are forced through a hose to a nozzle, under 60 pounds pressure, where they are picked up by a stream of air compressed to about 100 pounds, admitted through a second hose.

As the spray strikes the side of the engine, the hot water washes off the dirt, and the distillate leaves an oily finish.

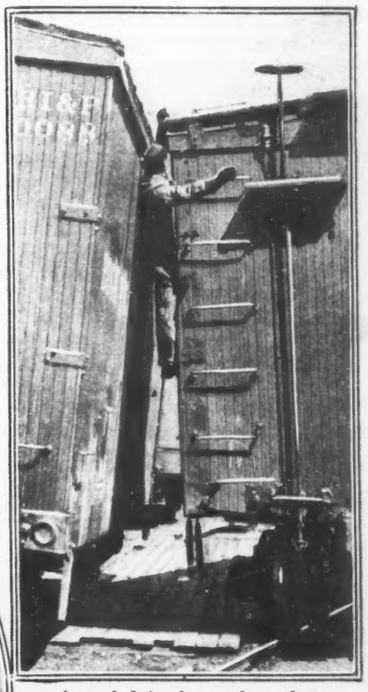
These Pictures Saved a Thousand Lives

PICTURES like these helped save the lives of more than 1000 railroad employees last year! On one eastern railway "Safety First" education reduced accidental deaths among employees from 254 in 1913 to 106 in 1921, and injuries from 13,851 to 12,646.

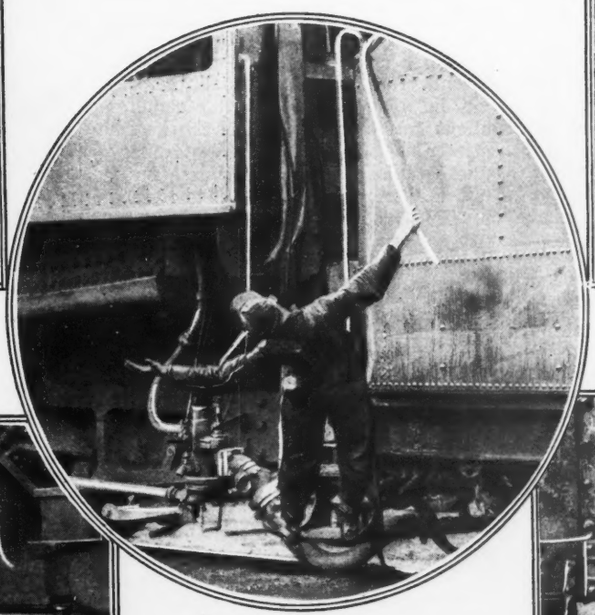
But carelessness still causes 87 per cent of railroad accidents, officials say. In the United States about 2500 employees are killed and 150,000 injured annually. Passengers injured number less than 9000; pedestrians, trespassers, and others, about 150,000.



This brakeman was standing on the coupler of the moving car. The coupler knuckle moved, throwing him beneath the wheels

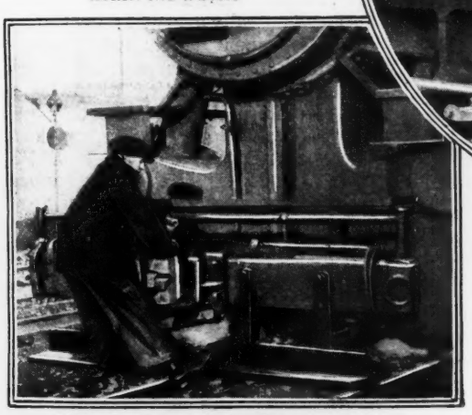


A car left in the yards so that it will "just clear" cars on the next track endangers employees on a passing train



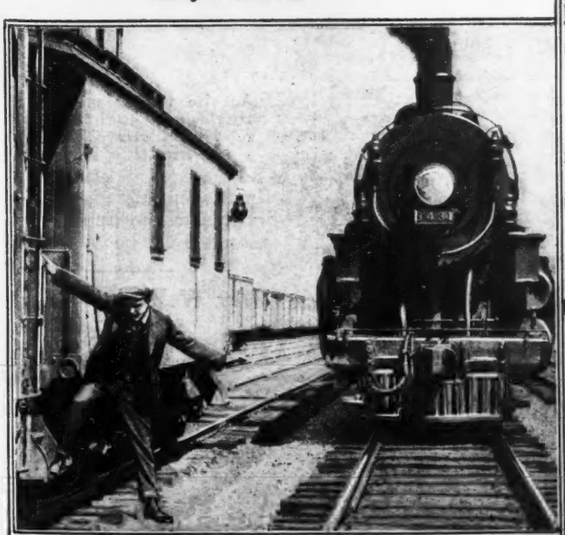
A dangling hose hanging from the tender caused a bad fall for the fireman, who mistook it for railing

Courtesy *National Safety News*

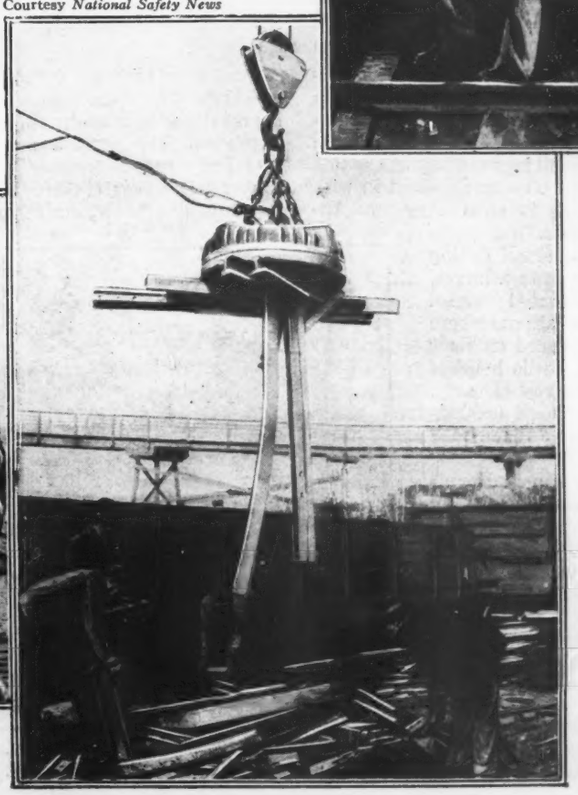


"Flipping" a switchyard engine from the front, as this man has done, causes many a fatal fall

Passing between moving cars is the cause of many deaths and accidents. The workman shown above "took a chance" once too often and was badly injured



An experienced employee was killed because he alighted from the side of the caboose next to a high speed track and stepped in front of a fast train. On the opposite side, he would have been safe



When the current suddenly ceased, this lifting magnet dropped tons of steel upon heedless workmen

New York Mapped by Sky Camera in Sixty-Nine Minutes!

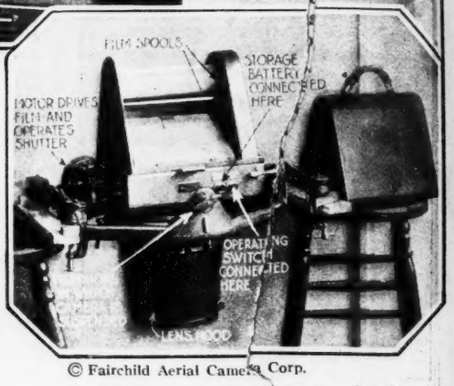
AN improved aerial camera and a skilful aviator combined recently to produce a detailed picture map of the entire Borough of Manhattan, New York City, in 69 minutes!

Flying at a height of 10,000 feet, the airplane passed swiftly over the island, while the camera clicked off a photograph of streets and buildings below every 27 seconds. After the flight 100 of these negatives were dovetailed into what is probably one of the most exact, detailed, and informative mosaic maps of a city ever obtained.

To the aviator was due part of the credit because of skill in maintaining an altitude of almost exactly 10,000 feet throughout the mapping flight; but it was the improved camera, and more particularly the invention of a new type of shutter, that made such a map possible.

The aerial camera, as improved by Sherman M. Fairchild, of New York City, uses film negatives, each 7½ by 9 inches, contained in a single roll of 120 exposures. The roll turns automatically as each exposure is made, and an improved device regulates the unwinding in such a manner that exactly the proper length moves into place for each picture.

One hundred negatives, exposed from a height of 10,000 feet, were dovetailed into this complete mosaic map of Manhattan



© Fairchild Aerial Camera Corp.

Driven by a small motor, the film roll of the improved aerial camera turns automatically as each exposure is made

A Gain in Accuracy

Previous devices were inaccurate and wasteful, since the winding spool became thicker as the film accumulated upon it, and a revolution that was correct at the beginning of the flight, when the reel was empty, became too great as the film was wound upon it.

A further gain in accuracy was obtained by a new "leaf" shutter, placed between the lens. The focal-plane shutter, of the type previously employed, produces distortion when used under certain conditions from an airplane. For example, assume that each negative is exposed 1/150 of a second. In this instance, the slit or opening in a focal-plane shutter requires about 1/10 second to travel the length of a nine-inch negative. In ordinary photography this is of no consequence, but in aerial work the image formed by the lens is also moving on the negative as the plane flies above the ground being mapped.

Thus, if the motion of the slot is parallel with the direction of flight, each picture will be compressed at one end of the negative and elongated at the other. This produces an error in scale when the pictures are assembled into the map. While the error can be corrected, the operation is complicated, requires elaborate apparatus, and is never quite satisfactory.

The inventor of the improved camera has succeeded in perfecting a leaf-shutter large enough to work with a lens three inches in diameter, and strong enough to withstand rapid operation, by employing a special high grade spring-steel. The shutter sections are thin, and devised to open and close automatically every 27 seconds. Since the shutter opens to its full width, the whole field of view is photographed instantaneously, eliminating distortion. A small electric motor operates the winding device of the shutter. Power is supplied by a storage battery.

Like those of earlier type, the camera is suspended by means of trunnions from a frame fixed on the deck of the airship.

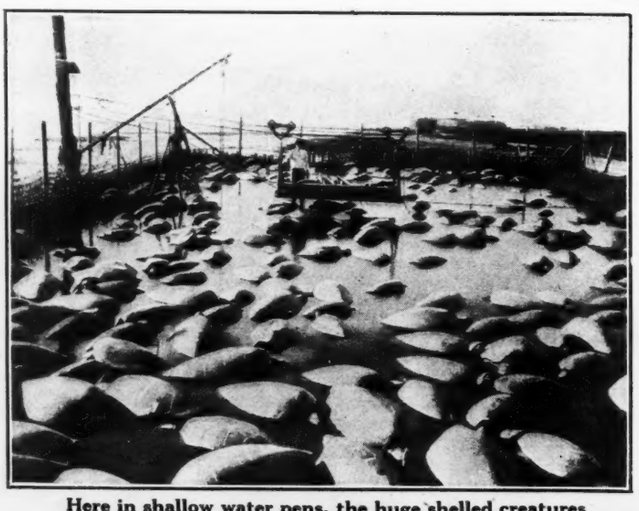
Canneries Handle Turtles by the Ton

GREEN sea-turtles, the raw material for turtle soup and tortoiseshell eyeglasses, are caught in the Gulf of Lower California, where they abound, by stretching strong rope nets of 19-inch mesh across the mouths of small lagoons just as the tide starts to go out. The turtles drift in with the tide, and as it ebbs they are entangled in the nets.

From the nets small fishing vessels carry them to a larger, specially constructed vessel lying farther out at sea, where the turtles are placed on their backs on racks, to lie helpless until they reach the cannery. Here they are placed in shallow pens that keep them fresh until needed.

One of the principal canneries slaughters about two tons every day. The size and weight of the turtles is so great that overhead conveyors, inclined runways, and similar equipment is necessary for handling the carcasses.

Turtles are extremely difficult to kill, incidentally, not so much because of their protective shell as because of their extreme tenacity of life. Incidents have been reported where a turtle's head that had been severed from the body for nearly 12 hours closed its jaws upon a man's hand. The explanation is thought to be that practically all the turtle's movements are so-called "reflex actions," in which no higher nerve centers are involved. In consequence, individual muscles sometimes continue to function long after life appears to be extinct in the body as a whole.



Here in shallow water pens, the huge shelled creatures await the day when they will be slaughtered for soup and eyeglasses

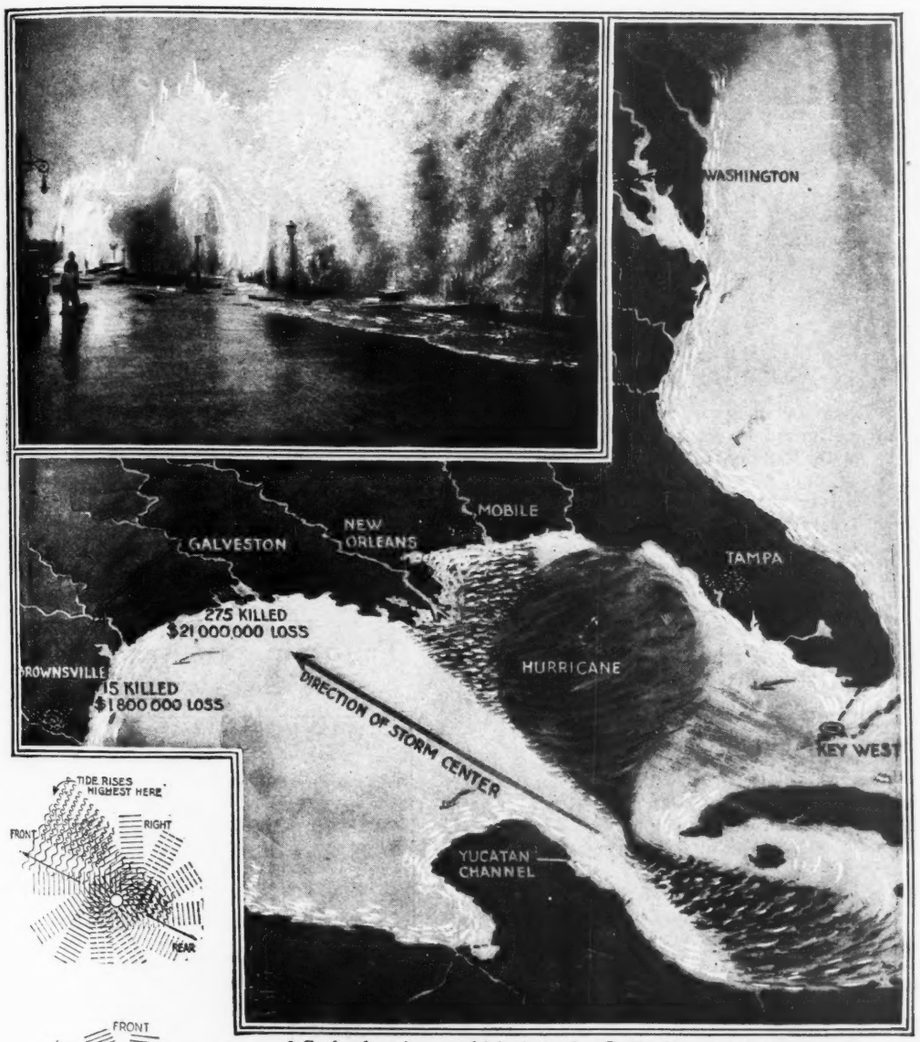
As the tide goes out, the turtles are caught in strong rope nets stretched across the mouth of a lagoon

Dry Well Cools House

FOR about 25 years a dry artesian well in Newark, N. J., has continuously emitted a steady stream of cold and dry air. The owner of the well, who is a woman, had this current of air piped into her house. The dry air is distributed through the whole house, cools the rooms in hot summer weather and is used to dry the clothes on washdays, also it takes the place of ice.

Weather Man Outwits the Hurricane

Tides Now Give Warning of Whirling Gulf Storms that Wiped Out 7225 Lives and $105,642,000 Property in 20 Years



AS the hurricane whirls into the Gulf, the greatest waves take a course slightly to the right of the storm center. Reaching shore while the hurricane center is still from 300 to 500 miles distant, these waves give warning by a pronounced rising of the tide. From the Weather Bureau at Washington, D. C., this warning is broadcasted to endangered points and to ships at sea.

The upper diagram at the left pictures Doctor Cline's discovery that the greatest waves travel in advance and to the right of the hurricane center, as compared with the previous theory (below) that the waves radiate symmetrically.

Insert shows great hurricane waves battering a sea wall.

BORN somewhere in the equatorial regions of the Atlantic, a tropical hurricane of cyclonic character sweeps through the Caribbean Sea, the Yucatan Channel, and the Gulf of Mexico, pursuing its path in a north-northwesterly direction, headed for the coast of Texas.

Three or four such hurricanes assail our coasts annually. Woe to the communities that lie directly in their path and have not received timely warning.

Coast Strewn with Wreckage

Many parts of the American coast between the Mexican border and the Florida peninsula are strewn with the wreckage of ships and buildings shattered by the fury of such hurricanes in the past. During the 20 years from 1900 to 1919, hurricanes on the coast of the Gulf of Mexico destroyed property valued at $105,642,000 and caused a loss of 7225 lives.

We have not learned to prevent these hurricanes; but at last, thanks to the careful studies and observations of Dr. Isaac M. Cline, for 20 years weather forecaster at New Orleans, it is possible to foretell, by measuring the tides, the coming of hurricanes within from 10 to 12 hours after they enter the Gulf, and from 24 to 48 hours before they become dangerous to coastal cities or to ships leaving any of the ports.

During the 33 years in which Doctor Cline was stationed as weather observer at different points of the Gulf coast, he observed that cyclonic hurricanes are, in all instances, preceded by storm tides. The water begins to rise on the shore in front of the approaching hurricane from one to two days before the storm reaches the coast.

By careful observation of the increase in height of the tide waves, Doctor Cline discovered that it is possible to learn of the hurricane's approach, where its center is located, in which direction it moves, and where it will strike. He observed also that the rise above the normal tide begins when the center of the hurricane is from 300 to 500 miles distant.

Having determined that the point on the coast that shows the greatest rise of the tide is invariably slightly to the right of the point toward which the hurricane is headed, Doctor Cline is able to determine the center and course of the storm and to mark them on the map of the Gulf region. Drawing a line through the storm center pointing in the direction in which the hurricane is moving, and another line at right angles to the line of motion, then dividing each line into equal parts, Doctor Cline obtains four quadrants. The waves and swells of greatest size and length are developed in the rear right-hand quadrant of the cyclonic area and move through the smaller waves in front of the storm toward the shore in the direction of the storm.

Waves Warn of Storm

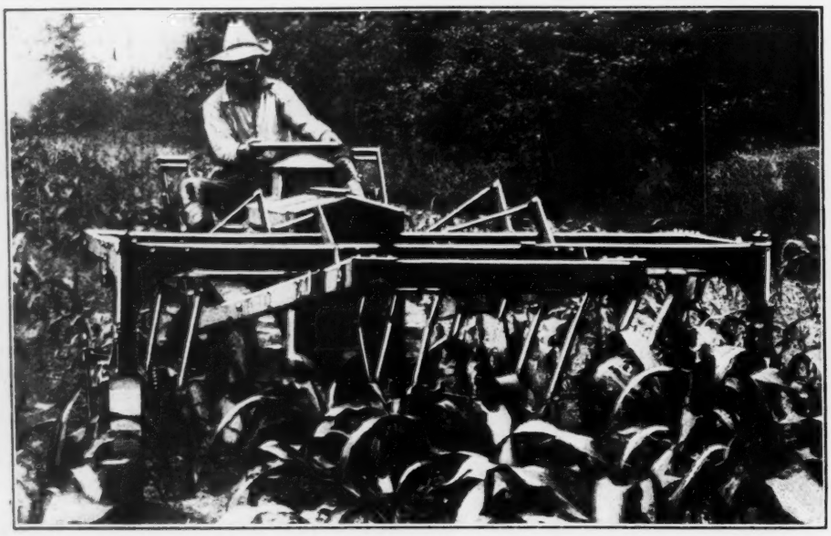
The speed of the long waves that herald the approach of the hurricane varies between 30 and 45 miles an hour, while the cyclone center progresses at a rate of not more than from 12 to 15 miles an hour. This difference in speed makes forewarning possible.

Seated at his desk in the Washington headquarters of the Weather Bureau, the forecaster, like the commander in chief of an army, every two hours receives reports of weather conditions, speed and direction of the wind, and height of the tides from all observation stations on the Gulf coast, from Key West to the Mexican border. On the map of the Gulf region before him, he marks the rise of the tide at each point, as well as the direction and speed of the wind.

To him, these data speak a clear language. They tell him that a cyclonic storm has entered the Gulf. They give him the approximate distance of the storm center, the direction in which it moves, its extent and speed, and they indicate the point at which it will strike the coast one, sometimes even two, days later. Immediately warnings are flashed to the points threatened.

The enormous importance of Doctor Cline's discovery may be inferred from the fact that in 1920—the first year in which his method of forecasting was employed—although there were several unusually severe hurricanes, only 18 lives were lost, two small vessels wrecked, and property valued at less than $100,000 was destroyed in the coast cities and towns.

Cultivator Is "Cart before the Horse"



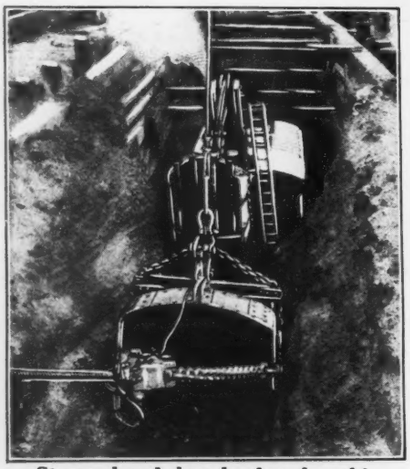
AMONG the new farm machines being developed to suit the tractor, is a three-row cultivator attached to the front of the machine, and pushed instead of pulled.

The tractor used with this specialized equipment is itself specially designed for cultivating work. It is narrow enough to pass between two rows of corn, and may be turned in its own length. This cultivator handles three rows at once instead of one, and placed in front where the driver can watch the cultivators, the tractor can be driven at full speed without fear of uprooting whatever the crop that is being cultivated.

Steam Shovel-Drag Bucket "Team Work" Effective

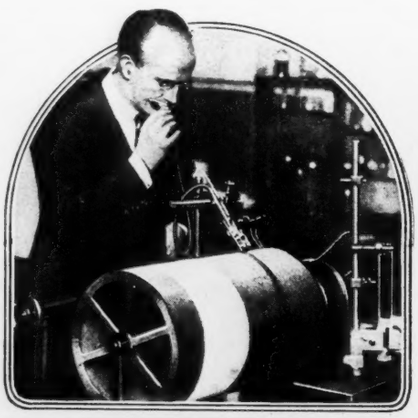
IN digging a sewer trench where a soil composed of hard yellow and blue clay proved too stiff for ordinary dragline methods, a contractor of Detroit, Mich., conceived the idea of using a steam shovel to do the actual digging, and employing the drag bucket simply to carry the clay away. Fifteen hundred feet of sewer was dug in record time by this surprisingly efficient combination.

"Team work" between the two mechanisms was easily effected. First, the shovel, of 20-ton size and with the continuous-tread type of mount, was placed in a pit and set to digging a cut 16 feet wide and from 24 to 27 feet deep. Deposited by the shovel on a bench about 15 feet above the floor of the cut, the loose clay was removed by a dragline.



Steam shovel-drag bucket dug this trench and removed the clay

The average output of the two machines was 350 cubic yards a day, and the best day's work 400 cubic yards.



Here is the stylus record of voice vibrations in speaking the letters "b," "u," "t," and "h"

Tone Record Aids Deaf

DEAF and dumb persons may learn lip reading more quickly now that the Phonetics Department of University College, London, has invented a machine that records the pitch of the human voice in speaking any particular word.

Persons born deaf find it difficult to understand how the voice rises and falls in tone. While they can interpret movements of the lips, they have little conception of the vibrations and the sounds these movements indicate.

By means of a flexible stylus set in motion by the voice, the new machine records a tone record on smoked paper attached to a rotating cylinder.

AS a special service to readers, the Editor will be glad to supply the names and addresses of manufacturers of devices mentioned in this issue.

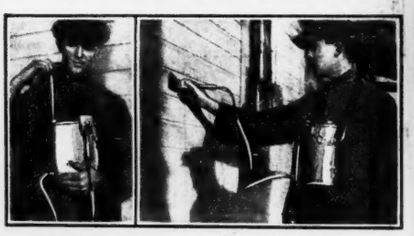
Pen Writes with Fire to Protect Checks

A "FIRE-WRITING" pen or stylus is the latest invention devised to prevent the fraudulent alteration of checks. A tiny point, heated red hot by electricity, scorches the paper, blackening it sufficiently to prevent erasure of the figures, yet not enough to obliterate the writing.

Heated by electricity, this pen point scorches the paper to prevent erasure

The hot-point is set in a porcelain holder. The fingers of the writer are protected in addition by a small metal shield.

Fountain Brush Replaces the Old Paint Can



A FOUNTAIN paint brush that combines the advantages of the hand brush with the speed of the compressed-air paint sprayer has been invented for house painters by Frederick J. Miller, of Iowa.

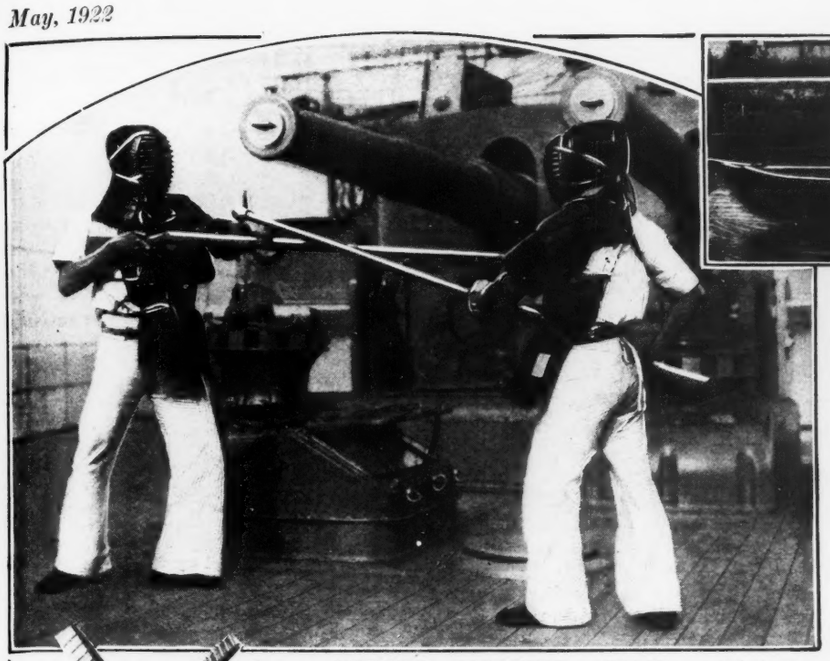
Instead of continually dipping the brush in an open pot of paint, the painter straps a flexible container about his waist. At the front and back of the container are two metal plates, squeezed together by strong springs. This pressure forces the paint out through a tube that leads through the hollow handle of the paint brush and ends in a narrow nozzle in the brush bristles.

The handle of the brush contains a spring stopper so that the paint can reach the bristles only when the painter presses a button with his thumb, releasing the flow.

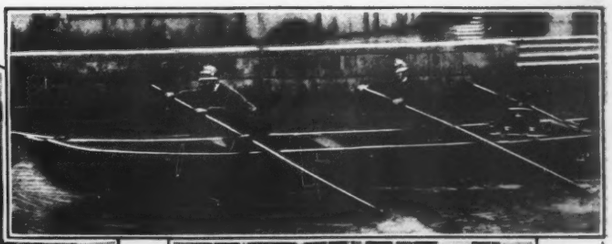
League of Nations Adopts New Standard Coin

THE League of Nations recently struck off one coin (franc-or) which typifies the coin standard under which all League calculations will be based. It contains .3225805 of a gram of gold, 90 per cent fine, and is worth .1925 of a dollar expressed in American currency.

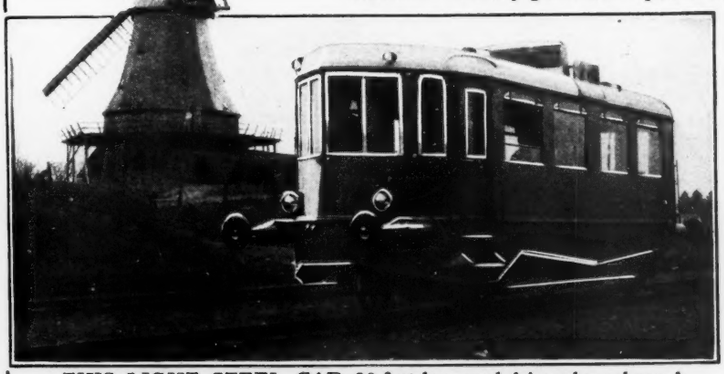
The coin is octagonal and carries the inscription "S.d.N.1921," which means *"la Société des Nations."* Only the one coin will be minted, since it will be used merely as a standard and not for circulation.



© Keystone **ANCIENT JAPANESE ARMOR,** with helmet and lacquered plates, still survives in protective suits worn by the Mikado's sailors in fencing matches. Dummy guns have replaced swords

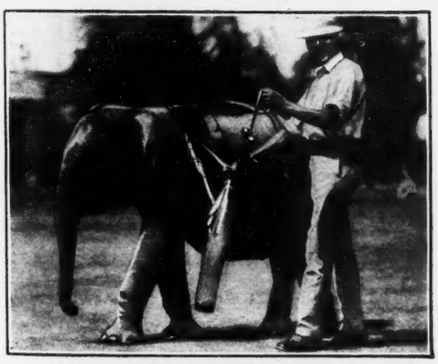


VENICE FIREMEN who once manned the oars whenever an alarm rang, now speed through canal-streets in a motor-driven gondola. The old hand power fire boat (above) was equipped with hose reels and a hand pump. In the modern craft (below) a motor drives boat and pumps

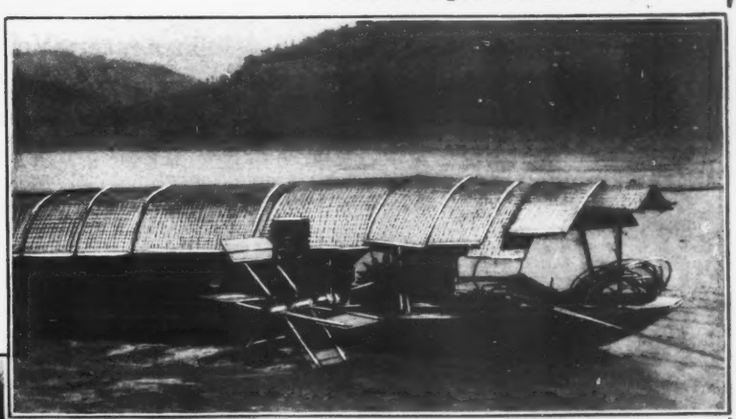


THIS LIGHT STEEL CAR, 30 feet long and driven by a benzol engine, is now used on local lines in Denmark. It is streamlined and weighs only nine tons. Its maximum speed is 35 miles an hour

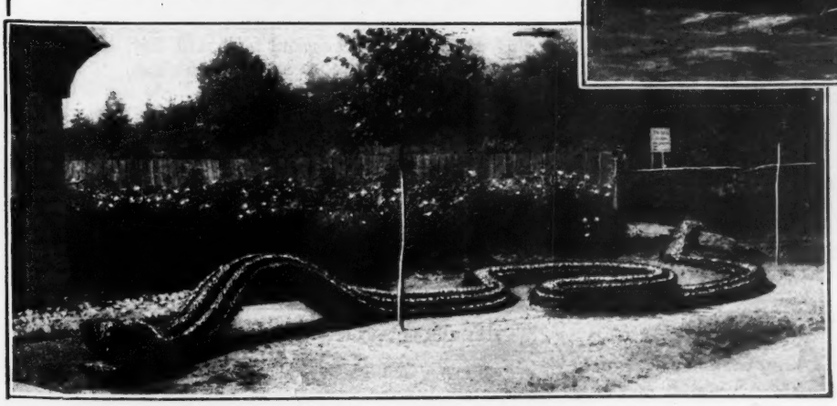
REAL MOVIE TEARS are produced by soft music and an eyedropper. A violin and irritating solution do the trick



A BABY ELEPHANT, serving as caddy at Miami Beach, Fla., picks up players' balls



FLOATING RICE MILLS, anchored in the swift current of the Yang-tze River, China, use their paddle wheels not for propulsion, but for turning the millstones. The river supplies the power. The boats are towed from place to place by coolies



A HUGE GREEN SERPENT, formed of grass and a lighter green shrub, is the creation of Napoleon St. Pierre, of Vancouver, B. C. He planted lawn grass and shrubs along a 96-foot frame

Chinese Steam Their Meals Over Straw in "Fireless Cookers"

This movable battery of Chinese "fireless cookers" uses rice straw for fuel. Note that not a chimney is in sight

From boats loaded with rice straw, lying along the waterfront, the Chinese consumer buys his fuel by the bundle

MUCH that is strange in Chinese cooking and Chinese food is due to the fact that the common fuel, in a land where wood is precious, is rice straw.

And even straw is scarce. As a result, Chinese kitchen utensils, stoves, and the meals themselves are planned in such a way as to make the most of the quick, intense heat generated by the rapid combustion of the fuel.

From the ricefields the straw is carried to the cities in scows. Semicircular stoves with thick walls of brick, mortar, or clay are used for burning it. The metal cooking utensils are in the shape of deep, round jars, and project into the body of the stove through an opening into which the neck of the utensil fits tightly. Such a stove is essentially a fireless cooker. Its thick walls absorb the heat, allowing practically none to escape up the chimney.

It is not adapted to baking or roasting; therefore most Chinese pastry is steamed rather than baked.

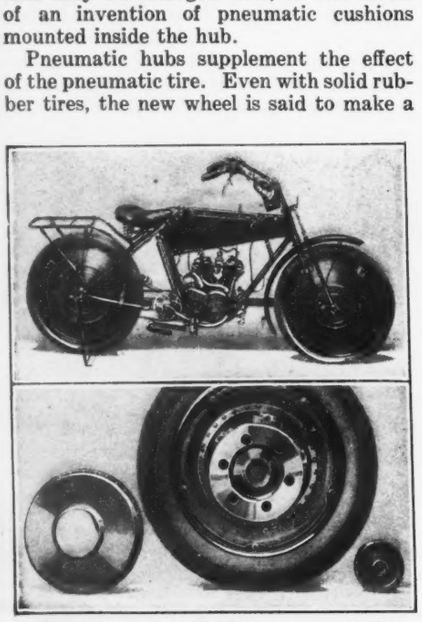
Thick wooden covers that serve as heat insulators are placed over the mouth of the boiling pot. Where the food is to be steamed, a circular wooden frame like a small barrel six or eight inches deep is placed over the stove opening.

Although chimneys are rarely seen in Chinese kitchens, the stove, placed against a wall has a small flue opening outside. A chimney on the roof is the exception, as a strong draft is not needed.

Pneumatic Cushions Put Spring in Auto Wheel

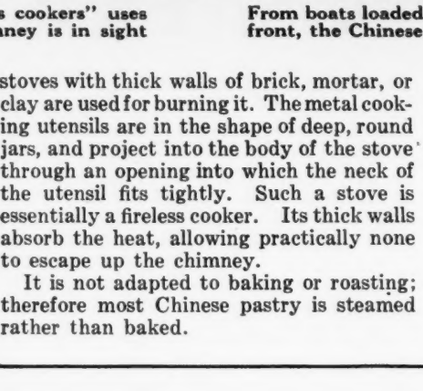
AUTOMOBILE designers have said that improvement of springs stops at the axle, and have classed wheels as "unsprung" or non-resilient weight. But this idea may be changed now, as the result of an invention of pneumatic cushions mounted inside the hub.

Pneumatic hubs supplement the effect of the pneumatic tire. Even with solid rubber tires, the new wheel is said to make a car ride easily, tending to transform the sudden jolt into a steady, even strain.



The pneumatic wheel on a motorcycle (above); with hub cap removed (below)

The hub consists of five air compressors arranged radially between the axle bushing and the spoke ring. They are in the form of cylinders, each with a dustproof piston. A system of valves fills the cylinders with air and empties them automatically.



New Grinder Resurfaces Tungsten Valves

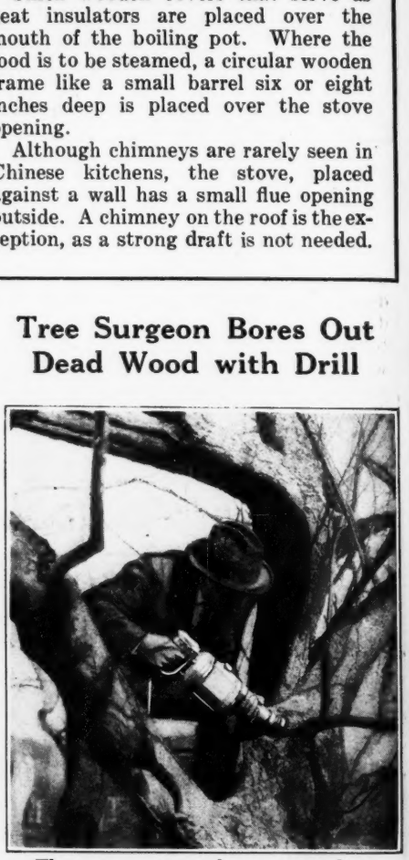
A VALVE-GRINDING tool that will resurface and polish the tungsten valves of the average car in 90 seconds has just been perfected. In the past, resurfacing of tungsten valves has been practically impossible.

A file, coarse on one side and fine on the other, is utilized as a cutting medium. The valve is set in at a true angle, lined up in two V-shaped slots, and held in place by a ground-bearing face on the tool handle. This bearing face is engaged by a feed screw.

With the apparatus set up in this way, the handle is revolved with the left hand, and the file, which is supported on two rollers, is operated with the right. The cut is very rapid, and the valve is refaced with extreme accuracy.

It is customary to test a refaced valve against a two-point bearing surface, and it will be noted that with this new tool the valve is held in this position all the time the cut is being made.

Tree Surgeon Bores Out Dead Wood with Drill



The tree surgeon cleans out a diseased cavity with the electric drill

THE tree surgeon, armed with a giant portable electric drill that closely resembles the familiar dentist's equipment, now bores out diseased cavities in fruit trees with a specially adapted cutting tool or "burr" invented by F. A. Bartlett.

Besides routing the diseased wood from the holes, and preparing the cavity for the concrete filling, the machine can be used for removing bark and for boring holes for bolts and tie-rods used to brace weak branches. The device further shapes the hole so that water will not run in between the live wood and the concrete.

AS a special service to readers, the Editor will be glad to supply the names and addresses of manufacturers of devices mentioned in POPULAR SCIENCE MONTHLY.

Dynamite Digs 700-Foot Ditch in Split Second

New Low-Freezing Explosive Converts 200-Acre Swamp into Valuable Farm Land and Protects from Overflow

SINCE the discovery of a new non-freezing formula, dynamite has become the ideal ditching agent for swampy land too soft to support a ditching machine, and too full of roots to permit hand shoveling. Also it is neat, quick, and cheap.

With the aid of dynamite made after this new formula, four men recently dug a trench 700 feet long, 12 feet wide, and 4½ feet deep in half a day! On the estate of L. G. Kaufman, 15 miles north of Marquette, Minn., it was found that a ditch through the side of a 200-acre swamp would not only drain the swamp and convert it into valuable farm land, but would also protect adjoining land from overflow.

A ditching machine traveling on a track and using a clamshell bucket dug the first 1200 feet of ditch through comparatively high and dry sandy soil. Then the swamp was encountered and no good "footing" for the ditcher. Fortunately, conditions were ideal for dynamite ditching. The mucky condition of the land guaranteed the success of the "propagated blast," in which a string or series of shots are fired by the transmitted concussion from a single cap and fuse. Such obstacles as bush, stumps, and even embedded timber, were easily overcome.

As the explosion leaps from one charge to the next, the onrushing water fills the ditch

Above, the newly made ditch is shown immediately after the heavy head of backed-up water had flowed through

A few trial shots were fired to try out conditions. This is highly recommended by the experts, who believe that it is cheaper to "learn by doing" than to guess. It was found that charges placed three feet deep gave the best results, probably because a comparatively solid bottom gave increased lifting power to the charges.

Three rows of holes were made, the rows and the holes being 20 inches apart. The holes were poked to a uniform depth of three feet and in each hole a stick was placed to serve as a marker. When approximately 200 feet of holes were ready, beginning at the ends and working toward the middle, a single stick of dynamite was dropped into each hole and shoved to the bottom with a wooden rammer. There was no tamping, the opening of each hole being simply closed with a thrust of the heel of the operator's rubber boot.

With each charge in place, the blasters were ready to set the detonating charge. For this purpose a single stick was capped with an ordinary No. 6 cap, a four-foot length of fuse was attached, and the charge placed midway of the length of the three lines of holes. To give additional "kick," an extra stick was dropped into the hole with the capped charge.

A match was touched to the split end of the fuse and the ditchers scurried away to a safe distance. Then came a heavy jarring of the ground. For a moment the air was smoke black with rocketing mud, water, and root fragments; next a rat-a-tat-tatting of falling debris over half an acre of swamp—and the first 200-foot section of ditch was completed.

By noon, three more "shots" were loaded and fired. The third shot completed the 700 and some odd feet of ditch and the heavy head of backed-up water released by this last shot soon removed the residue. There was a notable absence of heaped-up soil paralleling the course of the ditch, always an unpleasant feature of ditches that are dug by "shovel power" or with a ditching machine. To assure a uniform bank on each side of dynamited ditches, it is customary to cut a shallow trench before the shots are fired. In technical language this is called a "berm." It serves to effectually confine the blast to the desired width. Most dynamite does not propagate successfully below 50°F. The new low freezing dynamite, however, works at much lower temperatures.

Wearing hip boots, workers are seen above burying sticks of dynamite along the course of the ditch to be "dug," and placing identifying stakes

The photograph above was snapped immediately after the explosion had let the water through. Note that no debris is seen on the banks

The Wizard of the Telephone Who First Sent Speech by Wire

How an Accident to a "Musical Telegraph" Experiment in a Boston Garret Developed into the "Most Valuable Patent Ever Issued"

[The story of how Alexander Graham Bell, ranking among *Popular Science Monthly's* greatest contemporaries, had to prove to the world he was not "crazy."

POPULAR SCIENCE MONTHLY was three years old and Alexander Graham Bell was 28 when, owing to an accident to a spring in his experimental "musical telegraph," Bell heard a faint sound over a wire connecting two rooms in a Boston garret.

Inspired by his chance discovery, Bell gave directions that night for making the first telephone, a crude affair with a diaphragm of goldbeater's skin, suggested by experiments with a dead man's ear. For 40 weeks the perverse apparatus chattered only inarticulate noises. Not until March 10, 1876, did the baby telephone utter its first words:

"Mr. Watson, come here. I want you."

That first message came in the nick of time; for the man whom Bell wanted for a father-in-law had issued an ultimatum that if Bell wanted his daughter he'd have to stop his crazy attempts to talk through a wire.

Bell had been so successful in teaching deaf mutes in Boston, that he had won a professorship of vocal physiology at Harvard. Then he allowed his experiments to absorb all his interest and so lost his professorship.

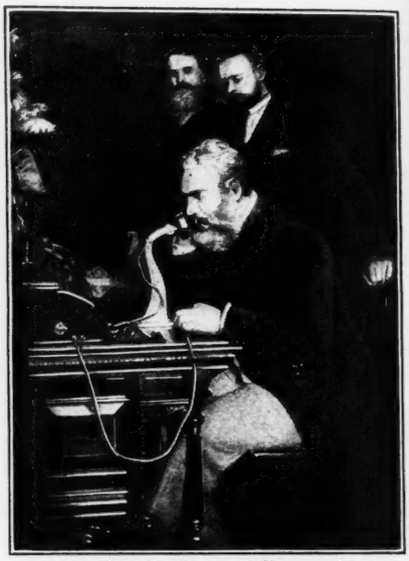
On his twenty-ninth birthday, March 3, 1876, Bell received his first telephone patent, "the most valuable single patent ever issued." The telephone was exhibited at the Centennial Exposition, but it would have been overlooked if Mabel Hubbard, Bell's sweetheart, had not cried for her lover to go to Philadelphia with her. He boarded the train without a cent, so Mabel had to pay his fare, while papa took care of him after his arrival.

At the exposition, he was cordially greeted by Emperor Dom Pedro, which so impressed the judges that they revoked their refusal to try the telephone. Bell's invention became the exposition sensation.

For the next 16 weeks Bell and Tom Watson, his mechanic, ignored the clock in frenzied experiments with hundreds of diaphragms, magnets, and mouthpieces. The first outdoor test, between Boston and Cambridge, October 9, 1876, convinced the newspapers at last that Bell was not a faker.

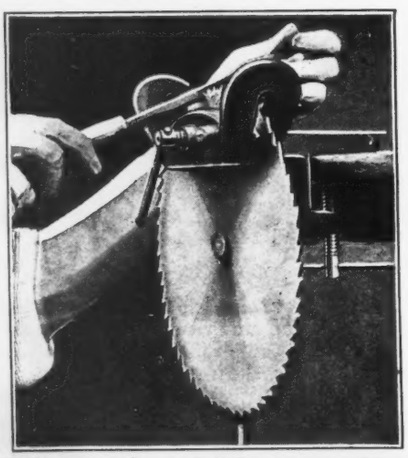
The first regular outdoor line was put up in April, 1877. Bell and his backers were so hard up, they offered the telephone patents to the Western Union for $100,000. They were laughed to scorn. Next the Western Union and other claimants tried to crowd them out of the field. The costliest patent war in history ensued, lasting 11 years and including 600 lawsuits.

Today there are approximately 20,000,000 telephones in use in the world.



Alexander Graham Bell, speaking the first long distance telephone message from New York to Chicago

Vise Holds Circular Saws



BY means of a stud sliding on a steel bar, a new bench vise will hold circular saws of any diameter, keeping the teeth in proper position for easy filing. A movable jaw operated from the outer side of U-shaped pieces by a small screw, clamps the saw against an unusually broad back plate. The vise grips the saw close to the teeth so that the blade will not buckle nor vibrate while being sharpened.

The holder consists of a cast iron slot by which the vise can be fastened to a bench.

What Do You Want to Know?

Why the Stars Twinkle

Why do the stars twinkle while the planets do not?—B. A. C.

Stars twinkle because the minute shafts of light from their surfaces have to pass through the earth's atmosphere with its constant variation in density. It is not necessary that the air be in evident motion—such as in a storm—to produce the effect. In passing from one density to another, the slender beams are slightly bent one way and then another, which gives a twinkling appearance.

Planets do not twinkle because in comparison to the stars their surface is enormous. Whereas the light beam from a star is almost infinitesimal in diameter, that from a planet is comparatively a cylinder of large proportion.

Compression Pressure

What is the compression pressure in an automobile engine?—N. F. A., Phila., Pa.

The pressure varies between 50 and 80 pounds, depending on the design of the engine. Occasionally, engines are built with a greater compression than 80 pounds, for racing.

These figures regarding compression pressure apply only when the throttle is wide open. As the throttle is closed, the compression pressure is reduced, and may fall to a very few pounds with a fully closed throttle.

Wave Length and Radius

What relation does the wave length of a receiving set have to the distance over which it will pick up broadcasting stations?—A. O. R.

The wave length has nothing directly to do with either the transmitting or receiving radius of a wireless set. The term refers to the type of wave emitted by the sending station and that which can be tuned in by the receiving station.

Can X-Rays Be Stopped?

Are there any substances that are opaque to X-rays?—J. H. P.

No substances so far known are entirely opaque to X-rays. The three metals that most nearly approach this property are platinum, lead, and silver.

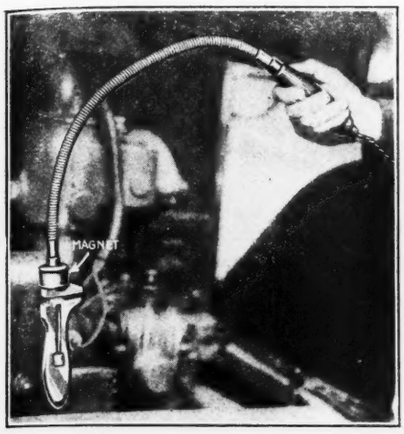
EVERY reasonable specific query in the field of general science addressed to the Information Department will receive a prompt reply.

While lengthy replies cannot be given to complicated questions involving extensive research or computations, this department aims to be of maximum service in supplying information as to what books or other sources may contain answers to these questions. Legal and medical queries cannot be answered.

A stamped addressed envelope must accompany each question, but the writer's name will not be published if he so requests.

Address the information Editor, Popular Science Monthly, 225 West 39th Street, New York City.

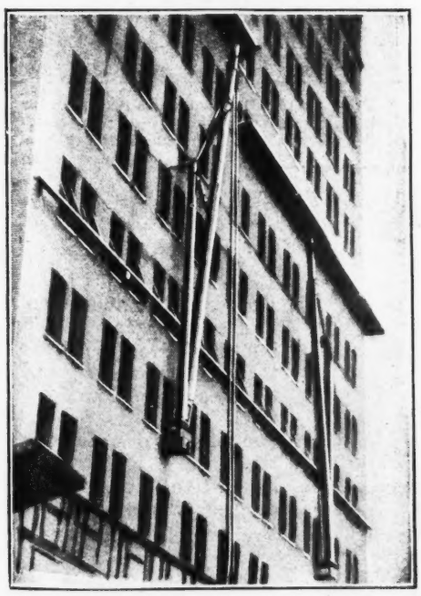
Magnetic Tool Finder Saves Your Temper



WHENEVER tools and small metal parts slip from the mechanic's fingers and fall into inaccessible parts of the machinery, a new magnetic tool finder has them out in a jiffy.

The gripping end of the device is a small powerful electromagnet mounted on the end of a flexible shaft about 18 inches long, so that it can be thrust around corners or into spaces too narrow and deep for the hands. As soon as the magnet is in contact with the lost article, the mechanic presses a button in the handle, which operates a switch that gives the magnet power to pick up the article. The lighting set of the car or shop is used as a source of current.

Derrick Rigged on Side of a Skyscraper



FORCED to mount two derricks on the side of a half-completed skyscraper, where it was impossible to install the usual type of rigging, a Western contractor solved his problem recently by using a system of cantilever supports.

Two heavy timbers, each 12 inches square and 30 feet long, were firmly bolted together, and placed so that they would act as a lever. The fulcrum was placed just inside the wall. The derrick rested on the outer end of the lever, which projected about five feet. The inner end was secured to the floor beams with iron straps. When a five-ton weight was hoisted, the strain on the anchored end was only one ton.

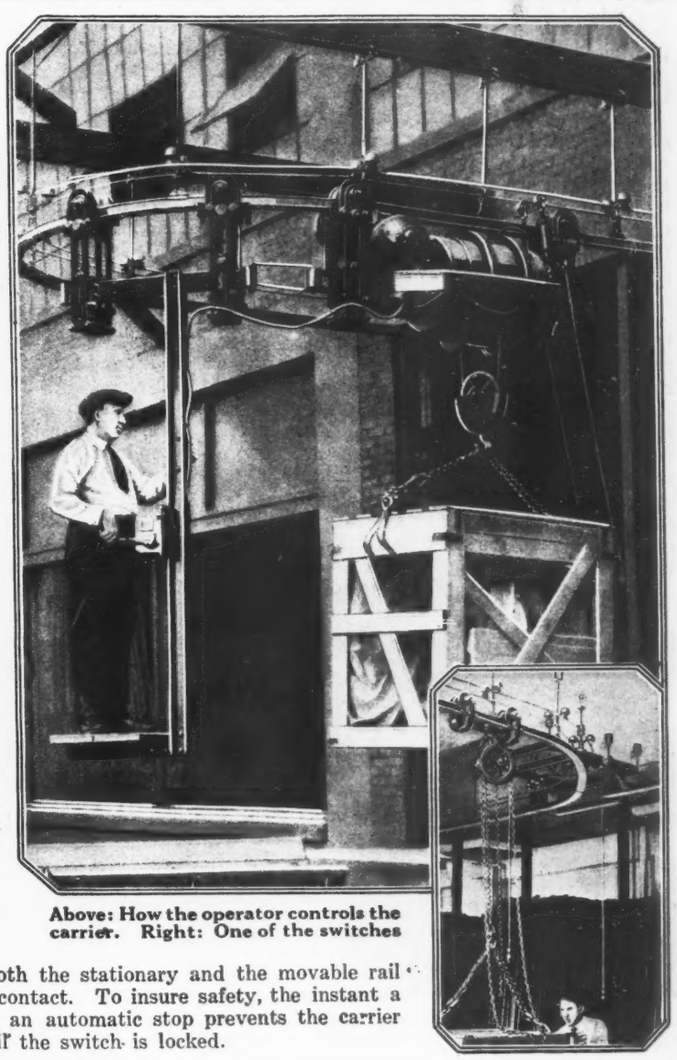
"Motormen" Run Cars on Ceiling Railway

OVERHEAD tramways, flexible in operation, and reaching into every nook and corner of a plant, cut costs and expedite the transfer of goods by moving material along the ceilings.

More than ordinary flexibility is secured through the use of an improved triangular rail, which can be bent into a radius as small as four feet. It is supported by iron hangers from fastenings placed about three feet apart and bolted either to the beams of the building, or secured directly to a cement ceiling.

The operator travels with the carrier on a small platform, directing the movements of the car.

Switching is effected by a switch of unusual design in which both the stationary and the movable rail are held in firm contact. To insure safety, the instant a switch is opened, an automatic stop prevents the carrier from passing until the switch is locked.



Above: How the operator controls the carrier. Right: One of the switches

It's Easy to Clean Teeth with Floss Now

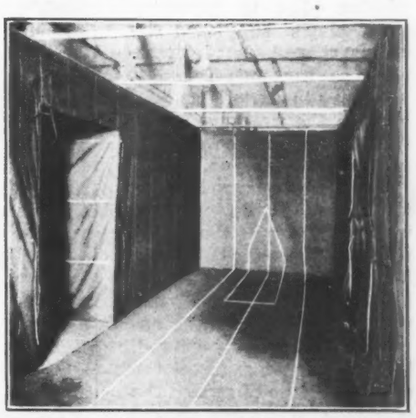
WITH the use of a dental-floss holder recently invented by Dr. F. L. MacDonald, of Waltham, Mass., cleaning the teeth with floss is now very simple.

The floss is placed in an airtight compartment in the hollow handle. About two inches of floss is drawn through a hole at the top of the holder, and the end wrapped about the projecting arm. Tightening a knurled clutch prevents the floss from unwinding.

Army Canvas Stops Leaks in Freight Cars

THE leakiest freight cars can now be converted into safe grain carriers, it is claimed, by means of a new interliner of heavy, olive-drab army canvas.

When the car is prepared for a load, all projecting nails and sharp corners that might cut the cloth are removed. The liner then is fastened inside the car by means of rings along its upper edges. After the car is loaded, the rings are slipped off and the edges of the liner laced together.



Canvas-lined car, showing laces that fasten the liner over the load

Science Irons Out Kinks in Bricklayer's Back

AFTER ages of stooping, reaching, and bending, the bricklayer at last is beginning to unshackle himself, through scientific system, from useless, back-breaking motions.

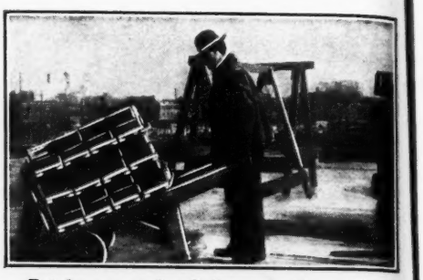
Even now, if bricklayers of ancient Rome should return to earth, they probably would observe little change in methods—unless they should be employed on one of the buildings being erected by the system recently developed by Major Frank C. Gilbreth, efficiency expert. Here they would discover what are said to be the first real improvements in 7000 years!

The gain in speed and reduction in effort has been demonstrated by two photographic action records of the movements made by a bricklayer in laying a short course of brick first by the old method, then by the new system. These photographs were taken with an ordinary camera. To record the movements of the bricklayer, a small, brilliant electric light was fastened to each of his wrists. In this way every movement of his hands was recorded on the negative by a bright line.

Comparison of the combinations of movement lines proved conclusively that with the Gilbreth system the bricklayer's movements are not only far less numerous, but also shorter. Instead of stooping, he stands erect and his hands move in straight lines. The reason for this is that all his materials have been brought as close as possible to him and to the wall on which he is working.

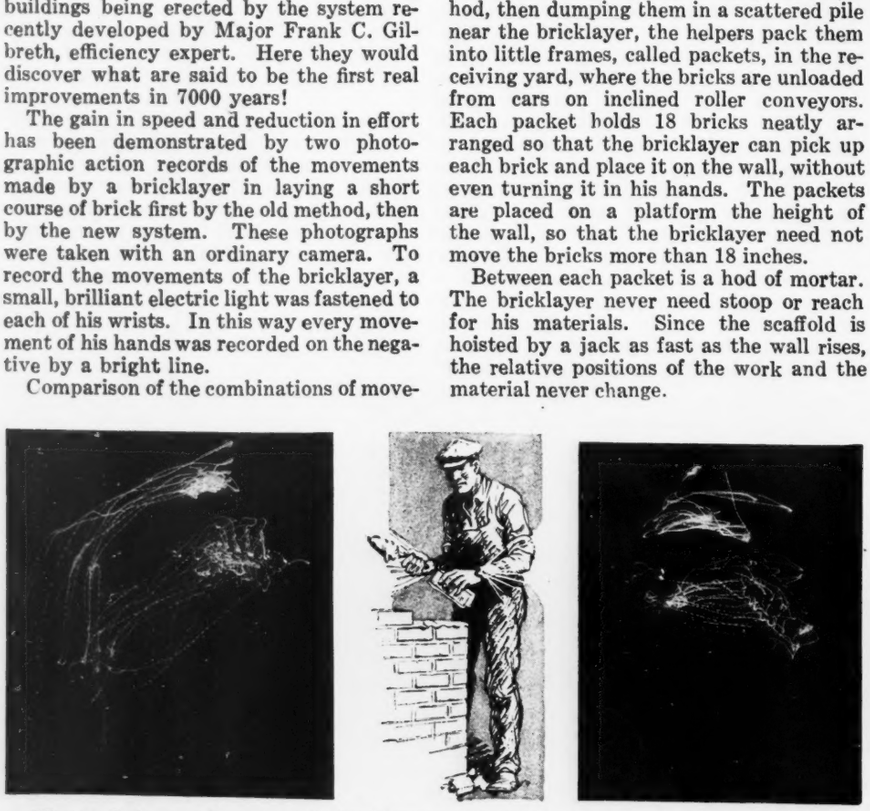
Instead of loading bricks one by one into a hod, then dumping them in a scattered pile near the bricklayer, the helpers pack them into little frames, called packets, in the receiving yard, where the bricks are unloaded from cars on inclined roller conveyors. Each packet holds 18 bricks neatly arranged so that the bricklayer can pick up each brick and place it on the wall, without even turning it in his hands. The packets are placed on a platform the height of the wall, so that the bricklayer need not move the bricks more than 18 inches.

Between each packet is a hod of mortar. The bricklayer never need stoop or reach for his materials. Since the scaffold is hoisted by a jack as fast as the wall rises, the relative positions of the work and the material never change.



Bricks are unloaded on gravity roller conveyors. They are not handled separately until they reach the bricklayer's hands

Exit the hod carrier. By the new method one wheelbarrow carries 240 bricks in packets or wooden trays



Electric lights on the wrists of a bricklayer produced the photographic action records shown above. Contrast the many long, stooping movements of the 7000-year-old method (at left) with the comparatively few short movements at right

With bricks in neat rows and mortar boxes raised from the floor, the bricklayer is relieved of stooping

Wooden Piles Pin Wrecked Locomotive Fast to River Bed

WOODEN piles that had been driven directly through the cab and driving wheels of a wrecked locomotive buried in the sand of the South Plate River of eastern Colorado, recently blocked every effort to salvage the engine.

At first the wrecking crew believed it impossible for wooden piles to penetrate steel plates supported by compact sand, but eventually the workmen found it necessary to cut off the piles beneath the wreckage before the engine could be dragged ashore by their crane.

The wreck occurred during the spring floods, when a weakened span of the bridge fell into the river with the locomotive. The gap in the bridge was repaired with piles. A short time later another wrecking crew arrived, built a coffer dam about the engine, cleared away the sand, passed a strap around the locomotive with the aid of a deep sea diver, hooked on a 150-ton crane and two come-alongs, and started to pull.

A powerful crane couldn't budge the locomotive until piles that had been driven through the cab and driving wheels were cut away

The wreckage wouldn't budge. There was power and to spare to lift the engine, but the piles pinned it immovably to the river bed. When the two piles were cut loose from the bridge structure, the locomotive was readily dragged ashore.

Seeds Glued Fast

IN windy, desert countries plant seeds must get underground as soon as possible; hence many varieties give out a kind of natural mucilage that glues them to the ground as soon as they come in contact with water.

Even a heavy dew will sometimes liberate the glue, which is strong enough to prevent the seed from being blown about by the wind, and facilitates the entry of the rootlets into the soil.

Super-Dam Will Harness the Mighty Colorado

World's Greatest Power and Irrigation Project Will Turn Millions of Barren Acres into Land of Wealth and Opportunity

By John Anson Ford

who was sent by POPULAR SCIENCE MONTHLY on a 400-mile motorcycle journey across deserts and mountains to get firsthand details about the government's vast power and irrigation project in the Colorado River basin

"SHE'S a wicked stream! And before we get her harnessed, we shall have to overcome some of the biggest obstacles this country's engineers have ever faced."

It was big Ray Gossett speaking, as he stood on the bank of the mighty, swirling Colorado River, and pointed to the black mouth of Boulder Canyon, three quarters of a mile away. He was explaining that this gorge with its sheer walls rising 1200 and 1400 feet above the river forms what engineers believe is a matchless site for a dam—a structure the like of which the world has never seen.

Here on the border line between Nevada and Arizona, the Federal government proposes to construct a dam that will rise 735 feet above bedrock, creating a reservoir with an area of 160,000 acres, and backing up the waters of the Colorado for 80 miles. The Virgin River, a tributary, will be backed up for 40 miles. This tremendous reservoir will have a storage capacity for 31,000,000 acre feet, far surpassing the largest reservoir in existence—the Assuan dam on the Nile, with a storage capacity of 3,500,000 acre feet.

400 Miles for News!

Gossett is the man on the ground directly in charge of the United States Reclamation Service camp engaged in preliminary investigations to determine by drilling the location of bedrock at this and a near-by site known as Black Canyon. What this giant of a man had to say about the project interested me intensely, for I had motored more than 400 miles across deserts and mountains to get firsthand information and to inspect the wild territory in which this work is being undertaken.

Between the 1200-foot walls of Boulder Canyon, Nevada, Uncle Sam will build the greatest dam in history—735 feet high. In charge of preliminary work is Ray Gossett, in the foreground

Tremendous benefits are promised from the great project, to which the Federal government has officially committed itself through Secretary A. B. Fall and Director A. P. Davis of the Reclamation Service. A vast barren waste is to be made marvelously fruitful; one of the continent's mightiest and most treacherous rivers is to be tamed; immense power now wasted is to be developed and delivered to farmers and manufacturers scattered over ten states; untold wealth, now hidden, will be revealed in countless barren mountains; a region now almost unknown to the outside world will attract thousands of tourists by reason of its scenic beauties.

All these advantages can be claimed for the Boulder Canyon project alone, while the development of the entire Colorado River basin, of which this project is only the first big step, will result in far greater benefits—increasing tenfold the wealth, productiveness, and population of a vast Western region. The complete harnessing of the Colorado will cost more than the Panama Canal, and will be by far the greatest public improvement ever undertaken by the government.

A Threefold Purpose

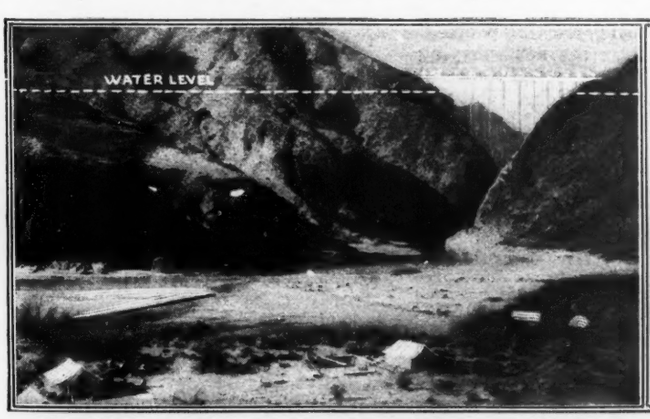
The incentive for harnessing the mighty Colorado is threefold:

First, flood control, which will save vast irrigated districts adjoining the lower Colorado from threats of perennial inundation.

Second, development through irrigation of 4,000,000 acres of land now arid, in addition to better irrigation of 2,000,000 acres under cultivation.

Third, the increase of hydroelectric power development from 100,000 horsepower (the present total for the entire basin), to 5,000,000 horsepower—or one half the total hydroelectric power now generated in the entire United States. This phase alone is sufficient to stagger the imagination. The total electrical energy of Niagara, developed to date is 760,000 horsepower—a figure that is nearing the maximum for that great power site.

From a point on the northern border of Arizona, midway between New Mexico and Nevada, as a center, describe a circle with a radius of 500 miles. The territory within the circle represents approximately the vast ex-



The black mouth of Boulder Canyon (between the two cliffs at the right), with the government camp on the river bottom that will be flooded by a huge lake

The old West and the new—burro and motorcycle meet, 25 miles from habitation, in the typical Nevada desert country. The writer stops to chat with a prospector

panses that will directly benefit from the irrigation, power, and flood prevention project.

Ten states are included, wholly or partly, in this territory—the southern half of California, all of Arizona and Utah, most of Nevada, Colorado and New Mexico, the southern parts of Idaho and Wyoming, parts of Texas and Oregon—and in addition, larger areas in the northern part of Mexico.

Other Power Sites

Ultimate development includes, in addition to the development of Boulder Canyon, the construction of power plants at Lee's Ferry, Marble Canyon above the Grand Canyon, and Diamond Creek, 50 miles below the Grand Canyon.

Maps of the Boulder Canyon region show a land where real roads are unknown. In their stead are a few trails, boulder-strewn, that wind over cliffs, across steep-sided washes, and lead through baffling sand. Accordingly I decided to undertake the expedition from Los Angeles in a motorcycle with a side car attached. On my arrival at the Boulder Canyon camp I was surprised to learn from Gossett that I was the first man who had ever traversed the trails to the dam site on a motorcycle.

"If the government follows the official recommendations of Director Davis and erects a dam at Boulder Canyon 735 feet high (600 feet above the bed of the river), it will submerge the quaint Mormon village of St. Thomas, Nevada," said Gossett.

St. Thomas was the village at which my side-car passenger, A. G. Goldsmith, and I had stopped the night before reaching the dam site. The fact that this town lies more than 40 miles away, in the peaceful Valley of the Virgin, serves to emphasize the magnitude of the Boulder Canyon project. It had taken almost a whole day to toil across the region to be submerged by the vast artificial lake. It is a wonderful region, yet today it is barren indeed. Here and there along bleak stretches we came upon bleaching bones that told of the death of animals who had wandered too far from the waters of the Colorado or the Virgin.

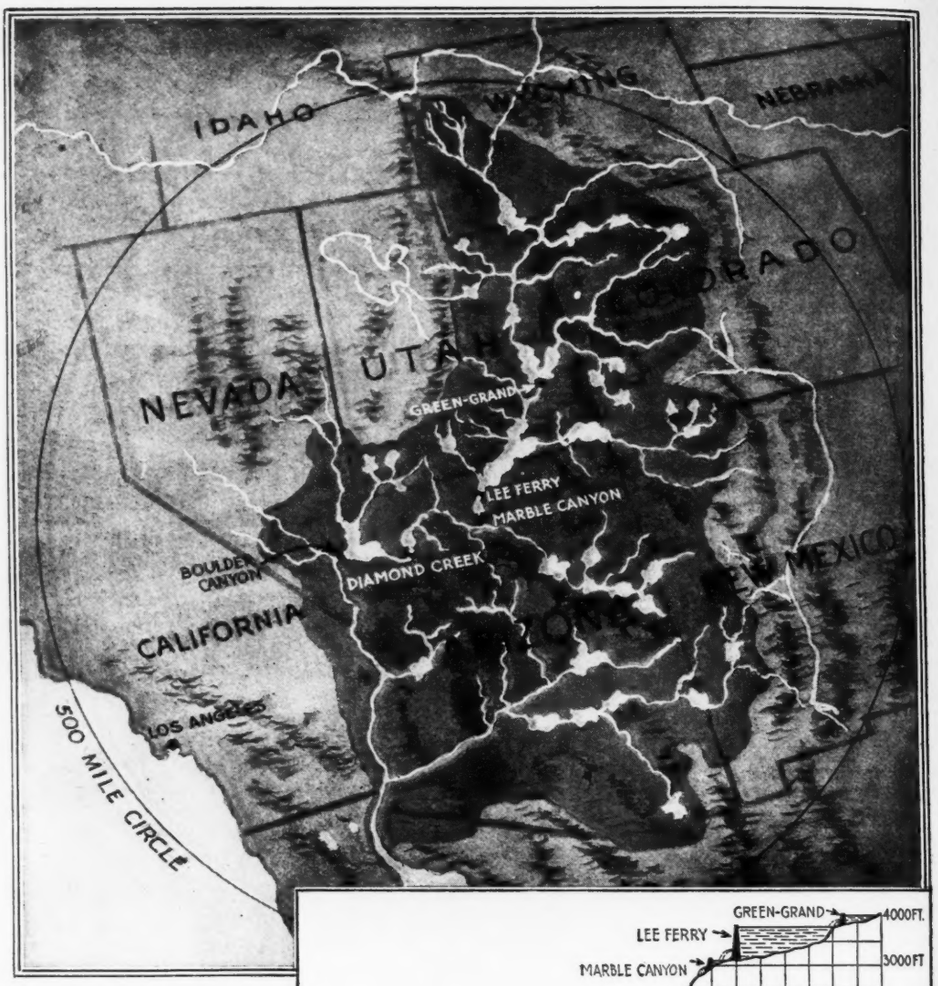
Yet as we worked our way along through the Valley of the Virgin and adjoining territory, we knew there was untold wealth about us. The village fathers in St. Thomas had told us of their explorations outside the sheltered nook in the mountains that harbors their settlement of 1000 villagers and farmers.

"Borax, gypsum, salt, gold, silver, and many other precious metals are to be found in this region," they said. "The building of the dam will bring us real roads, and this wealth for which many an illy equipped prospector has vainly searched, will be revealed and made accessible."

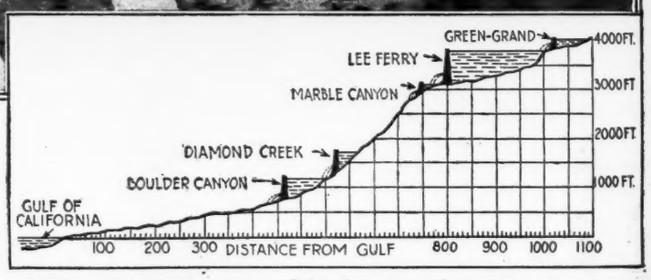
"But what will become of this quaint village?" I asked.

"We are a God-fearing, trusting people," was the reply, "and we are not worrying about the future. I think myself they will build a dam only 450 feet high. That will bring the artificial lake to within a mile or two of the edge of town and will not inundate any of our farms. Then our little settlement here will become the mecca for miners, engineers, railroad men, power men, and thousands of tourists."

Arriving at Boulder Canyon, we talked late into the evening with Gossett and his men, of the dam project and what it will mean to the country.



Within this circle of 500-mile radius, touching ten great states, is the vast territory that will be made fertile or receive power from the Colorado River development. The shaded portion of the map indicates the river basin, while the white lakes are proposed storage sites for flood control and power development



This profile of the proposed development shows the comparative volumes of water to be impounded by the five largest storage sites

$100,000,000 To Be Safeguarded

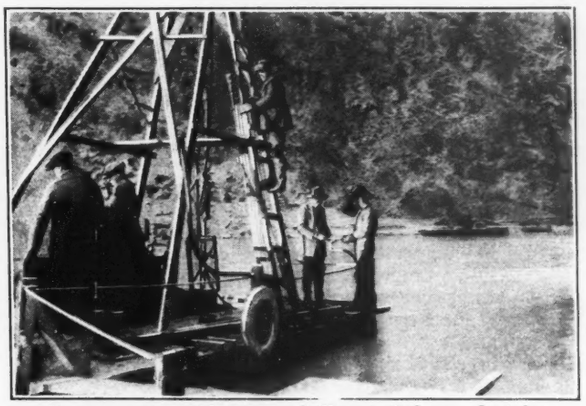
Two of the subjects on which the men in the Reclamation Service camp dwelt were flood control and irrigation. The estimated value of the irrigation development and allied industries below Boulder Canyon is $100,000,000. They pointed out that the Colorado at present is a recurring menace to this vast investment. Only last summer, when the melting snows of the mountains augmented the river, the Imperial Valley narrowly escaped inundation. Feverish work night and day was all that kept the levees from giving way and prevented a repetition of the disaster of 1905 when the river cut a new channel to the Salton Sea and damaged hundreds of square miles of fertile fields.

The construction of a 735-foot dam in

Across the vast desert land that waits the magic touch of water and electric power, the prairie schooner still toils—meeting, by chance, the writer on his motorcycle

Boulder Canyon will permit impounding no less than 31,000,000 acre feet of water—an amount about twice that which flows down this channel into the Gulf of Mexico in the course of a year. Not only will it be possible effectively to check floods when the water is high and so safeguard the 750,000 acres under irrigation below the dam site, but it will so conserve the water that an additional million acres can be brought under irrigation.

By desert highway it is 450 or 400 miles from Los Angeles—the greatest of the prospective users of Colorado River power—to Boulder Canyon—according to whether one travels the "old road" *via* St. Thomas, Nev., or goes down the new road that descends by a more direct route to the river from Los Vegas, Nev. To one who travels that long trail, as we did, visualizing all that the Colorado River project will bring about, the journey is filled with the most intense interest. All through the southwest there are villagers and ranchers dreaming of the days when the Colorado will be harnessed.



On a scow in midstream, drillers toil day and night with diamond drills to determine the condition of bedrock at the dam site

"Shall We Get Water?"

In the desert town of Victorville, California, a woman of moderate means asked me, "Do you think we shall get any benefit from the Boulder Canyon project? We have a little ranch out on the desert on the east side of Mt. San Antonio. I wonder if it will help us get water onto our land?"

It is hard to give a definite answer to such questions. Probably the ranch of my inquirer is at far too high an elevation to be reached by any of the water if gravity is depended on to distribute it. But without doubt electric power will be available at greatly reduced rates and that will mean that these desert ranches can afford many times the volume of pumped water that they now pay for.

Fifteen years ago the town of Searchlight, Nev., was a booming, "wide open" mining town of 4000 people. Today it is but a skeleton of its former self—a few unpainted frame stores, and hastily constructed houses set in the midst of a boundless desert. But if you talk with the remaining inhabitants, of whom there are only a few score, you will find that they, too, are hoping for another golden age for Searchlight.

A Desert Will Blossom

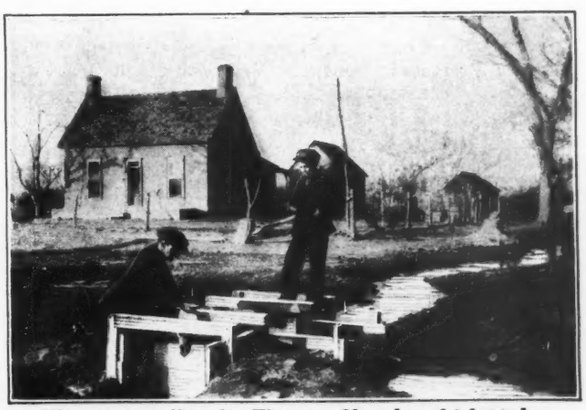
As for benefits to specific communities, there can be no question of the value to the vast territory as a whole. The desert will blossom as the rose. Manufacturing will receive a tremendous impetus, particularly in and near seacoast towns. The many valleys forming the lower lands of the Colorado River basin will be made green with flourishing crops. Flood control will not only free the Imperial Valley from a present serious danger, but will make possible a far greater development both north and south of the international border in the vicinity of the Colorado.

Then, too, desert folks are particularly interested in the cultivation of comparatively narrow strips of land in many places, forming the very banks of the Colorado. These low level tracts are said to possess some of the richest soil in the world—the accumulation of hundreds of years of periodic overflow of the river. At present cultivation of these potential Edens is difficult and uncertain because each spring or summer sees all the work of the year threatened by rising flood waters. In the future this menace will be removed, and what is now an uninhabited region will be dotted with prosperous settlements. Near the desert town of Needles, Calif., there is a tract of 30,000 acres of this rich river bottomland, awaiting flood control.

Tremendous engineering and political obstacles must be overcome before the Boulder Canyon project can be carried to completion.

First of all, there is the task of constructing a dam between two canyon walls such as are found at Boulder Canyon. What is to be done with the water while such a barrier is being laid, with foundations perhaps 135 feet below the river? The only way, says Gossett, is to construct *four* other dams to protect the one permanent dam while it is being constructed. To explain: One coffer dam must be built immediately above, and another just below, the site of the permanent dam, so that excavations can be made down to the surface of bedrock, which is covered by many feet of accumulated sand, silt, and boulders. But to make possible the building of these coffer dams two other temporary barriers are counted necessary by engineers, since special precautions must be taken against rapid changes in water levels and such dreaded phenomenons as "sand waves"—crests of onrushing water and fine sand that appear unexpectedly, due to swift current and a constantly shifting riverbed. This pair of outermost dams will be built of trainloads of rock dumped into the river in sufficient quantity to hold it in check.

But when these barriers have been completed, what will become of the water, some of which must be kept moving to the lands below? If the dam could be built in a few weeks, the answer would be simple, but the engineers' plans must provide for several years' work. The annual flow is approximately 16,000,000 acre feet and to carry the needed portion past the dam site it will be necessary to blast tunnels through the walls of the canyon.



"Street scene" in St. Thomas, Nevada, which probably will be submerged by the government's vast irrigation project. This view shows the present water supply in roadside ditches

Why Boulder Was Chosen

While it is almost universally conceded that Boulder Canyon will be the site for the first dam, some authorities believe that other sites farther up the river, notably Lee Ferry, should be the scene of the first activity. There a still greater lake could be created; but that site is farther from the regions that would be most benefitted by flood control, irrigation, and power development. It was this factor of distance that largely influenced Director Davis of the United States Reclamation Service when he officially reported to Secretary Fall in favor of the Boulder Canyon project.

The Panama Canal cost something like $300,000,000. The new task to which the United States has set its hand will eventually represent a far greater expenditure. Fortunately a body has been formed competent to solve the engineering problems that have arisen—the Federal Colorado River Commission, at the head of which President Harding has appointed Secretary Herbert Hoover. Associated with Mr. Hoover are representatives of the seven states having territory lying within the Colorado River basin. Each of these has passed the legislation necessary to the appointment of a representative on this commission.

States' Rights a Difficulty

One of the difficult tasks of the commission will be to arrive at equitable division of the benefits of the project. Each of the states, as well as Mexico, is prepared to push its claims concerning water and power rights, and it will prove no easy undertaking to arrive at a just decision among the conflicting claims. A further question to be decided will be the relation of private power and light interests toward the public improvement.

"We are not worrying about the Federal Commission's problems," said Gossett, good naturedly, as I bade him good bye. "We have a big job right here and now in gathering our data in the face of all the opposition offered by this wicked stream and a barren country that becomes terribly hot in summer.

"Some day the ground on which we stand will be the bottom of a lake whose beauties will attract thousands and which will be easily accessible by rail and highway. Our task is here."

Indians, by Secret Process, Shape 75-Foot Canoe from Single Log

© K. & H.

THE war canoes of the Makah Indians on Puget Sound, Wash., hold the record as the world's longest paddle-propelled water craft; and since even the Indians are losing the art of making them, the 75-foot canoe recently launched will never be exceeded, probably, in size.

The canoe was hollowed from a single cedar log, which was carved into shape and then softened in some secret way with boiling water until it could be stretched into form. Hard wood thwarts, inserted while the boat was still warm, kept it in shape after the wooden sides become cold and stiff. This swelling and shrinking process is a secret that the members of the rapidly dwindling tribe will doubtless carry with them to their graves.

In spite of their length, the boats are less than three feet wide and are only a foot deep. Formerly, in times of intertribal conflict, they were manned by crews of 50 men armed with bows and arrows, who all stood up simultaneously to fire a volley.

Newest Orchid Is Worth Thousand Dollars

ONE thousand dollars for a single flower! This is not too high a price to pay for a new variety of "educated" orchid, declares V. Ferraria, of San Francisco, who has just developed a flower unlike all others in form and color.

New varieties of orchids require painstaking cultivation and cross fertilization by expert gardeners. Long experiment with many kinds of orchids was necessary before this new hybrid could be produced.

Self-Winding Reel Carries Electric Cables

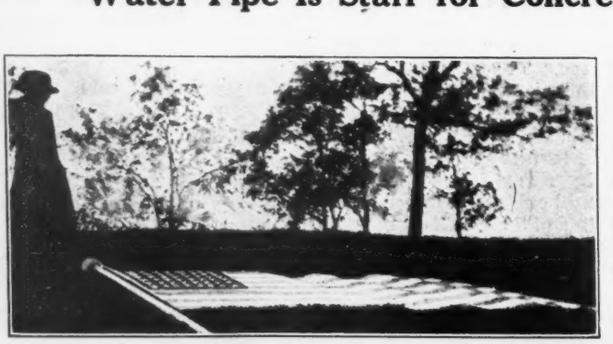
A NEW self-winding reel to carry the electric cable for portable tools to various points in the shop or garage, prevents the short circuits caused by continually dragging the cable through water. In addition it keeps the cable flexible and handy for use.

The reel is attached to the ceiling on a swivel, so that the cord may be led out in any direction. Sliding contacts in the supporting head maintain constant electric connection as the reel is turned.

The self-winding device consists of a spiral spring operated by a gravity controlled pawl that acts on a ratchet.

When the reel is unwound slowly, the pawl falls into engagement with the ratchet teeth and will lock the cable at any point, but if the cable is pulled out rapidly and then released, the pawl is continually knocked out of engagement by the oncoming ratchet teeth. When this happens, the cable is rewound by the spring, thus adjusting itself.

Water Pipe Is Staff for Concrete Flag



A NOVEL flag of concrete, with the Stars and Stripes painted on its surface, adorns the side of a hill near Chicago, Ill. A cast iron water pipe has been used for a pole. The surface of the concrete was troweled into waves, and painted so that it produces the effect of a flag waving in the breeze. The flag itself is 10 feet by six.

Rack Reduces "Upkeep" of Father's Wardrobe

A NEWLY invented clothing rack is said to reduce pressing bills by keeping a man's clothes ventilated and in proper shape overnight.

The rack stands beside the bed in place of a chair, and provides shoe-trees and clothing hooks as well as coat and trousers racks. The trousers holder is a flat steel spring that will hold the trousers either at the bottom or with the belt uppermost, without having to empty the pockets.

The rack is made of wood and stands 50 inches high. The fact that each garment has a definite place is said to give added speed in getting down to breakfast in the morning.

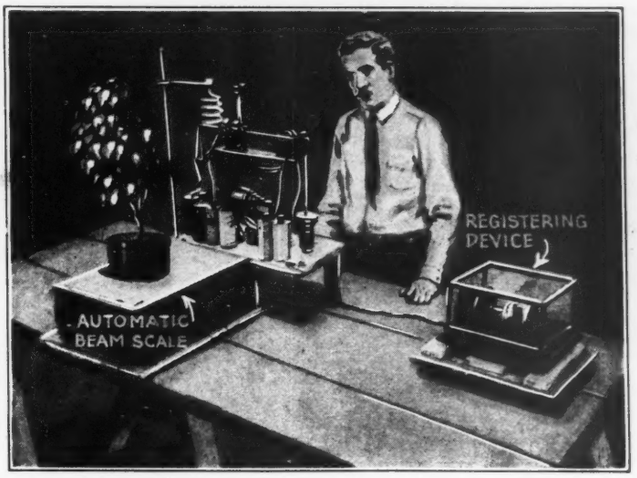
LIQUEFIED carbonic acid gas is often found in the interior of sapphires.

How Perspiring Plants Keep Air Healthfully Moist

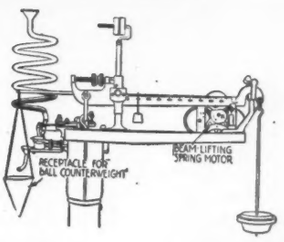
DO you know how much of the healthful moisture in the air you breathe comes from perspiration of the plants, trees, and grass around your home? Do you know that the average suburban lawn gives more than 10 barrels of water to the air every summer day?

To discover such facts as these, Uncle Sam, master farmer, has recently been conducting interesting experiments with ingenious devices, measuring and recording exactly the amount of water that "transpires" or evaporates from the leaves of plants in 24 hours.

The results have revealed the astonishing rate at which growing things, absorbing water from the soil, pass it off into the air, thus serving as Nature's automatic humidifiers for the atmosphere. One pot of alfalfa lost more than eight quarts of water in a single day, when the atmosphere was dry and the wind strong. The average amount of evaporation for a large plant like a sunflower is between a pint and a quart daily. Findings such as these show why potted plants in your rooms help to restore moisture to the heater-dried air which makes so many American homes unhealthful.



Placed on the platform of a delicate scale and carefully balanced, the plant is measured for evaporation by the weighing and recording apparatus shown above. As the plant loses weight, the beam of the scale falls, completing an electric circuit that drops a ball counterweight from one portion of the apparatus to another so as to restore the balance and register the amount of evaporation



To conduct the experiments, the United States Bureau of Standards has designed special weighing apparatus for these measurements under natural conditions, in the open air. The plant is placed on the platform of a delicate scale, and carefully balanced. Any loss in weight thereafter, of course, is due to loss of water. As the beam of the scale falls, it completes an electric circuit that opens a gate and allows a tiny steel shot to drop from one portion of the apparatus to another, restoring the balance. Each steel ball corresponds to a loss of 20 grams on the part of the plant. The shot are kept in a coiled pipe, and fall into a cone shaped receiver suspended on knife edges. A spring motor gives a positive lift to the scale beam every time a steel ball is dropped.

The recording device is similar to those used on automatic rain gages. It has a drum 12 inches in circumference that makes a revolution every six hours, and is continually offset by a screw so that four six-hour periods are recorded side by side on the same sheet. In this way, beside determining the total amount of water the plant breathes into the air, the apparatus charts the loss in connection with the time elapsed and the local weather conditions.

The apparatus works perfectly, except when sudden upward gusts of wind lift the plant, causing the recording of a transpiration rate that is abnormally high. Special provision is made to prevent more than one ball being delivered to the cone at a time, however, and no record is made unless a ball is actually deposited on the beam.

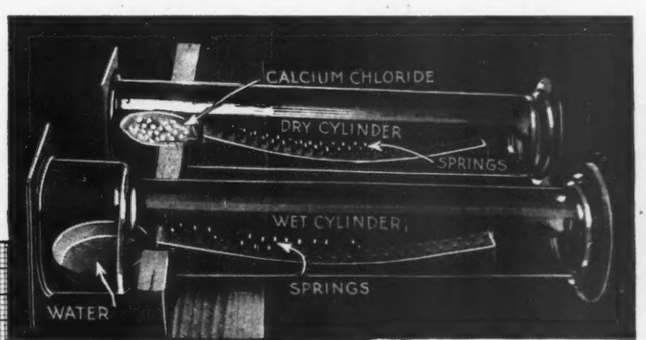
Tests Reveal Why Watchsprings Break During Thunder Showers

YOUR watchspring is most likely to break during a thunder shower. This has been proved by a painstaking series of tests recently completed by Herman Seemann, of Oberlin College, Ohio, whose results have verified a jewelers' superstition of long standing.

The tests have disclosed that the breakage is due, not to the electrical or magnetic effect of the lightning, but solely to the moisture in the atmosphere. Electrical effects can be ruled out because the mainspring of a watch is perfectly insulated by its metal case, just as the inside of a hollow steel mast or enclosed tank is the safest possible place to be during a thunderstorm. During Mr. Seemann's tests watchsprings were exposed to weak and strong magnetic fields without showing any weaknesses, yet graphic charts reveal that there is a distinct relation between the frequency of thunderstorms and the number of watchsprings broken.

Graphs depicting the number of thunderstorms at Cleveland as compared with the number of springs repaired by jewelers in the neighboring towns of Oberlin and Elyria, Ohio, over the period of a year, reveal that the maximum is in June, July, and August—this in spite of the number of people away on vacations.

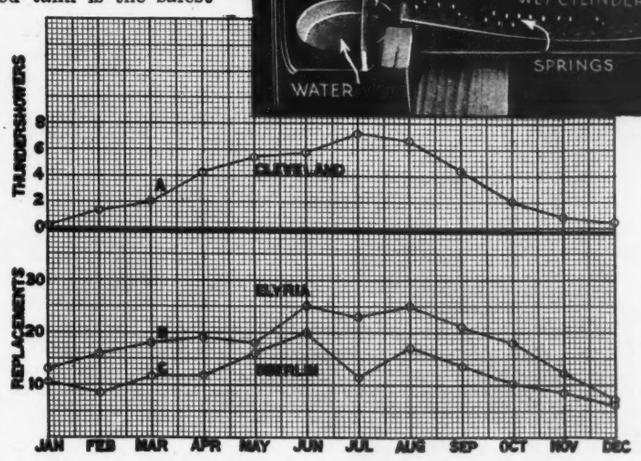
That breakage must be ascribed to moisture, was proved in this manner: Two groups of bent watchsprings were placed in airtight cylinders. One cylinder was kept perfectly dry by enclosing a dish of calcium chloride, while the other contained an open dish of water to keep the air moist. In the dry cylinder, after two months' exposure, not a spring had broken; but in the moist air half the springs broke during the first seven days! Careful oiling of the springs reduced the breakage about 50 per cent.



Bent springs placed in a dry cylinder withstood two months' exposure, while half of those in the moist cylinder broke in seven days

Under a powerful microscope, tiny spots of rust were found on the fractured edges of the springs, showing that the breakage was due to oxidation, which broke the skin effect of the spring. The outer layers of metals under tension perform most of the work, and when these are destroyed by rust, a fracture will soon follow.

The investigations seem to indicate that watchsprings wear out instead of rust out; by proper oiling their life may be doubled.



This chart reveals the striking relation between frequency of thunderstorms in Cleveland, and breakage of springs in Elyria and Oberlin

Your Right Hand Wins in Finger Speed Tests

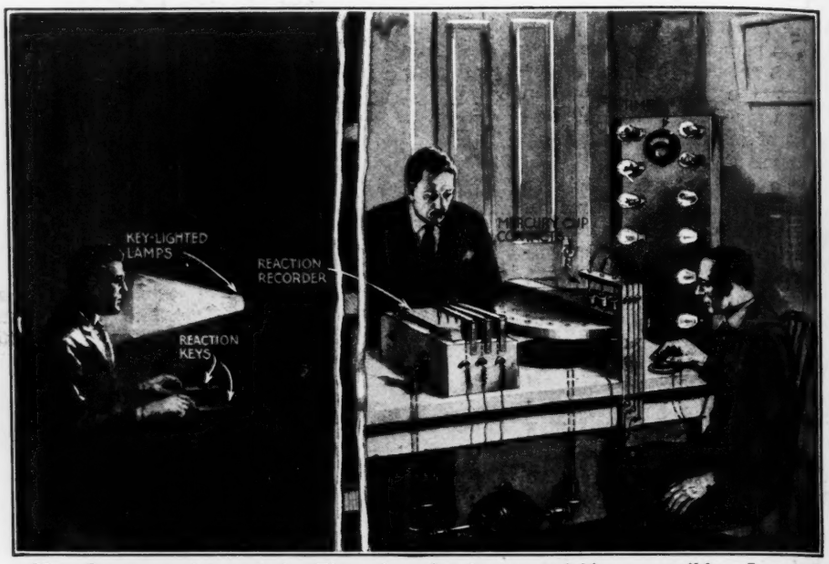
THE fingers of your right hand are quicker and more accurate than those of your left.

The ring finger of your left hand shows a burst of speed whenever it can work with the forefinger of your right hand; and it slows down noticeably when it must team with the middle finger of your left hand.

Two fingers, working together, are faster than one going it alone. And a combination of two fingers on opposite hands is faster than two fingers on the same hand.

Practice, while it increases the speed of all fingers, tends to increase the rate of the slow ones more than the fast ones, thus overcoming the handicap of the ones that lag naturally.

If you are a typist or pianist, perhaps you have already discovered some of these facts about the workings of your hands. They have been conclusively demonstrated recently by a series of tests conducted at the Carnegie Institute of Technology by Esther L. Gatewood.



How finger speed is tested. The subject sits alone in a darkened room with a specified finger of each hand resting on a key. When one of two electric lights flashes, he presses the corresponding key as quickly as possible. In an adjoining room a small motor driving a rotating disk lights the lights at irregular intervals, at the same time operating a recording instrument

Thousands of Experiments

These tests are particularly interesting in the light of the recent experiments with children conducted by Dr. John B. Watson, New York psychologist, and described in POPULAR SCIENCE MONTHLY for April, which revealed that up to the age of one year a child is neither right handed nor left handed.

In 70,000 individual experiments with adults at the Carnegie Institute, in which the speed of finger reactions to visual stimuli was accurately measured, the average reaction time was found to be 400 sigmas, or four tenths of a second. Compare this average with the speed of an expert typist who can copy 132 words a minute correctly for an hour, responding 625 times a minute, or about 10 times a second, to visual stimuli!

The scientific tests of finger reactions were made possible by development of an elaborate electrical apparatus, which records accurately and simultaneously the eye stimulus, the finger response, and the elapsed time, furnishing valuable data.

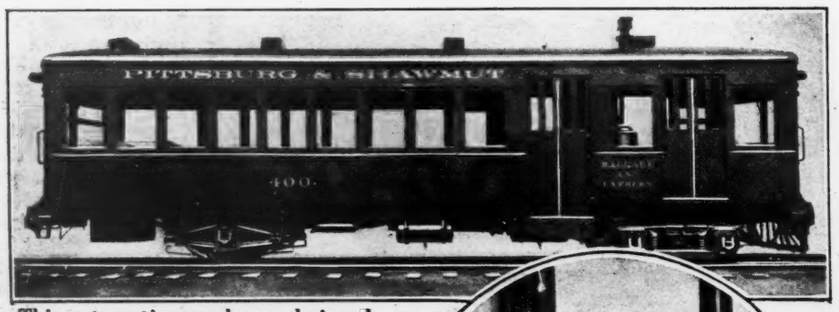
The person under examination sits alone in a darkened room with one finger of each hand resting on a separate key. Before him are two electric signal lights. When one of the lights flashes, he must press the corresponding key as quickly as possible, extinguishing the light.

A third red light between the two signals flashes after four tenths of a second, warning the subject that he is falling behind.

In an adjoining room is the regulating and recording apparatus. A small electric motor running at constant speed rotates a disk with a multitude of round-headed screws projecting from its surface. Above this disk is a line of metal cups filled with mercury, which are lifted up as the screws strike their bottoms, and brought into contact with wires hanging above them. This device lights the right and left hand lights haphazardly, so that the subject cannot anticipate what the next required movement will be.

The motor draws a strip of record paper under a series of pens, which mark on the moving paper the exact time that a light was flashed, the time that elapsed before the subject's pressure on the finger key put out the light; also whether the correct key was depressed, and whether the red, or tardy, light flashed.

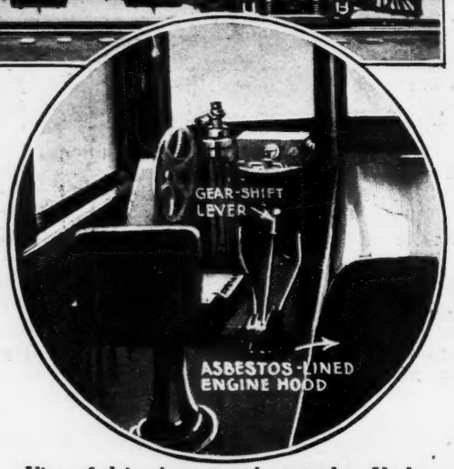
The Railroad Borrows the Automobile's Best—and It Pays



This automotive coach was designed for frequent service on branch lines

REDUCING operating costs from a dollar to about 10 cents the train mile, the latest gasoline-driven passenger coaches, built in St. Louis, Mo., are enabling railroads to operate their branch lines at a profit while greatly increasing train service in outlying districts.

The economies are the result of a unique combination of the best features of automotive equipment with the essentials of steam rolling-stock design, and are due particularly to an improved system of power transmission and arrangement of the rear truck.



View of driver's seat and controls. Under the hood is a 72-horsepower auto engine

The power plant, a four-cylinder automobile engine developing 72 horsepower at 1600 revolutions, is at the front of the car. The clutch is similar to that of a high-class automobile. From this point the power is transmitted by a longitudinal shaft to the main transmission. Here are four forward speeds with gear ratios ranging from 4.99 to 1, to 1 to 1. To provide for reverse, a second longitudinal shaft runs to an auxiliary reversing transmission that has two speeds only, 1 to 1 forward, and 1 to 1.085 in reverse.

Ease in repair and economy of maintenance are claimed for this system, since any gearbox can be reached without lifting the car from its trucks or sending it to the shops. Further, by separation of the various elements of the gear, wear is lessened and parts can be made more rugged. The rear driving truck is also arranged so that the brake rigging and gearcase can be removed from the car intact.

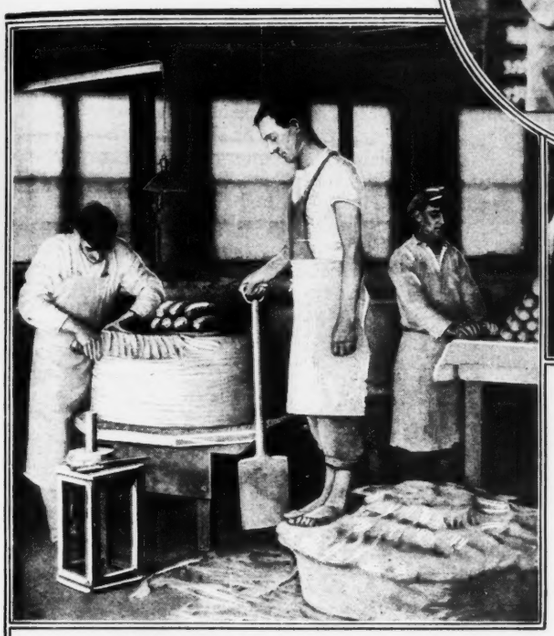
The engine is under a hood close to the driver's seat, with its radiator in the end wall just under the front window. The hood is lined with asbestos to permit small packages to be stowed in the space just above the engine.

The car is made with bodies of various types, which seat from 24 to 52 persons, depending upon the size of the baggage room. While designed especially for use on railroad branch lines, it is said to be suitable for use on suburban trolley lines.

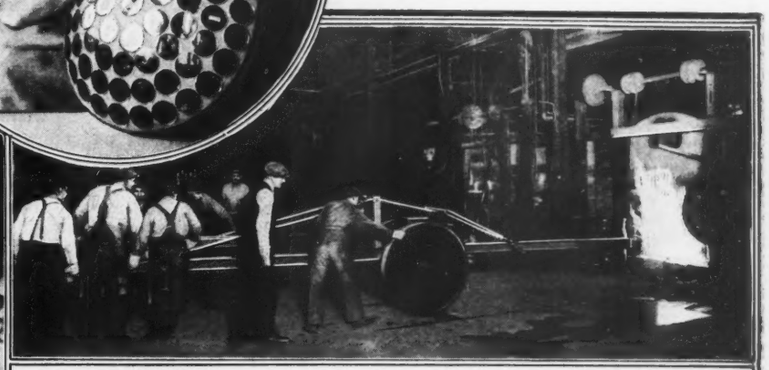
How Glass Bits Are Shaped for Defective Eyes

AFTER years of scientific study, eyeglass makers can supply lenses to correct any one of 134,764 defects of vision.

The exacting skill required to shape bits of glass for countless human eyes is shown on this page.



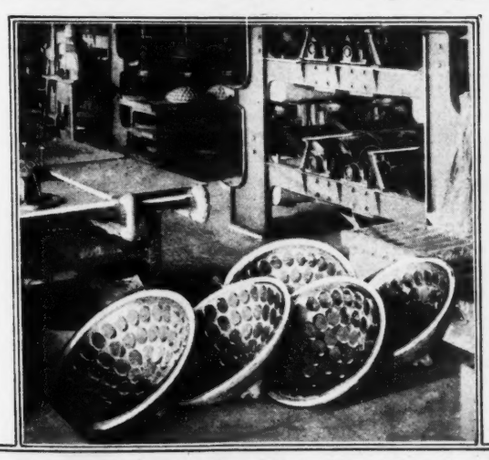
The manufacture of clay crucibles in which optical glass is melted at tremendous temperatures requires the exacting work of experts. The open clay vessel when completed, measures from 26 to 36 inches in diameter



When the glass is melted, the furnace door is lifted, and workmen, operating huge tongs on wheels, withdraw the white-hot pot

Onto the casting table—a smooth, iron slab—the molten glass is poured from the pot in front of a roller that converts the glass into a smooth, even sheet

For grinding and polishing, rough lens blanks are cemented to these metal blocks. Over each block fits a grinding shell



Concave blocks, with lens blanks fastened in place, ready for the grinding machines in the background

How blanks are cemented to the block. Warmed on a heating table, they are pressed into a coating of pitch

The Conquerers of the Clouds

How a Fluttering Toy and the Study of Birds Inspired the First Airplane

[The story of the Brothers Wright, who, among *Popular Science Monthly's* greatest contemporaries, have remained most secluded from the public gaze]

A toy helicopter, driven by a rubber band, was the Wright boys' first inspiration, in 1879, for the creation of a "flying machine"

Wilbur Wright

ONE day in 1879 the Rev. Milton Wright, of Dayton, Ohio, a bishop in the United Brethren Church, gave his sons Wilbur, age 12, and Orville, age 8, a toy helicopter that would flutter in the air a few minutes, its propeller driven by a rubber band. The toy so fascinated the boys that it determined their life work.

The Wright brothers had grown up and were running a modestly successful bicycle business when a chance item in a newspaper reminded them of their toy helicopter and focussed their attention on aviation. First they studied all that was then known about aeronautics, then, 21 years after the gift of the helicopter, they made their first attempts at gliding through the air. Quickly they discovered that all existing theories about flying were wrong, so they started from the beginning.

The brothers spent many hours lying on their backs outdoors studying the flight of birds. Other hours and months were devoted to experiments with the effects of currents of air, blown through a tube, on differently shaped sheets of metal.

In October, 1900, they were ready to try the air again in a glider designed on new theories of their own. They went to Kitty Hawk, N. C., because the weather bureau said winds there were strongest and steadiest. They sailed a total of two minutes. Next year they tried a larger glider with such success that in 1902 they made a machine still larger, with which they made many glides, the longest 662 feet.

The first flights in history in a power-driven, heavier-than-air machine were made by the Wright brothers on December 17, 1903. The first of these flights lasted 12 seconds, the last 59 seconds. Neither of the brothers ever would disclose which one of them made those epoch-making trips. They told nothing; for they were not then ready for patents, so they relied on secrecy for protection. They were not garrulous by nature. As *Hashimura Togo* said, "You have never heard true silence till you have talked with Wilbur Wright."

Their first airplane was of 12 horsepower; their second, in 1904, 16 horsepower. From September 26 to October 5, 1905, they made six flights averaging more than 15 miles. Then they knew they had a practicable airplane.

But by 1907 the brothers were confident enough to predict that airplanes would some day fly 100 miles an hour. In May of that year they made an official endurance test at Fort Meyer, Va., to meet government requirements. When Orville had circled the flying field for an hour, President Taft, one of a great crowd, applauded and cheered with the rest. After congratulating Orville when he alighted, President Taft said to Wilbur: "Your brother has broken your record."

"Yes," admitted Wilbur; "but it's all in the family."

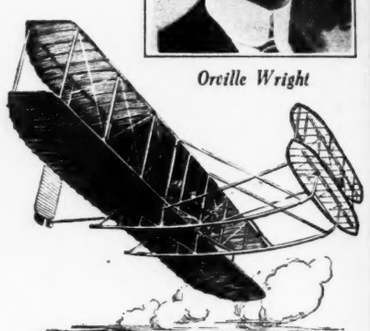
That reply was characteristic. It was never Orville or Wilbur who accomplished some marvel, but always "the Wright brothers."

Next year the brothers went to Europe to sell airplanes. They were loaded with honors.

Until 1910 there was no important knowledge of the art of flying that did not come directly from the Wright brothers. Indeed, their patents, upheld by the courts, included about all that is known of flying.

Wilbur Wright died of typhoid fever at his home in Dayton, Ohio, May 30, 1912.

Orville Wright



Which of the Wright brothers made the historic first flight in a power driven machine, December 17, 1903? Neither ever told

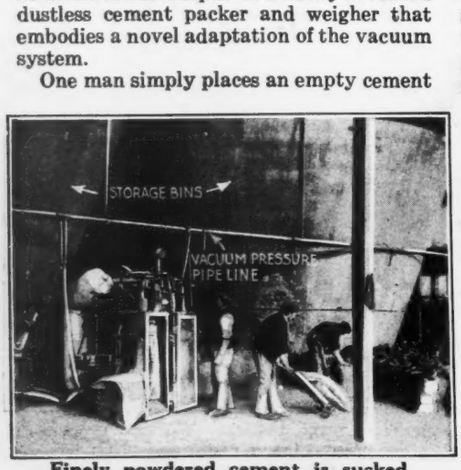
Automatic Cement Packer Fills and Weighs Barrels by Vacuum

ONE hundred and twenty tons of cement, packed and weighed in barrels in 10 hours is the output of a newly invented dustless cement packer and weigher that embodies a novel adaptation of the vacuum system.

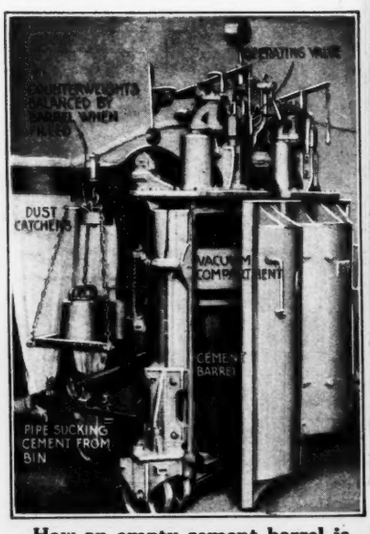
One man simply places an empty cement barrel under a loosely fitting packing hood inside an airtight compartment, shuts the door, and pulls the operating lever. This starts an exhausting fan that produces a vacuum in the compartment. The finely powdered cement is sucked into the chamber from storage bins through a large flexible pipe and drops from the packing hood into the barrel.

The barrel rests upon one platform of a scale, and when the weight of the cement equals that of the counterweights holding down the other arm, the platform drops. This movement automatically stops the electric motor and exhaust fan, and opens the door. The operator takes the barrel off the scale. The entire cycle has consumed less than two minutes.

To prevent dust from coming out when the door is opened, the first valve operated by the scale platform as it starts to move downward starts a small electric motor that sucks the air from the chamber when the doors are opened and catches the dust in porous filter bags.



Finely powdered cement is sucked by vacuum from bins into the air-tight filling compartment



How an empty cement barrel is automatically filled and weighed is shown above

"Scrapped" Warships Become Busy Merchantmen

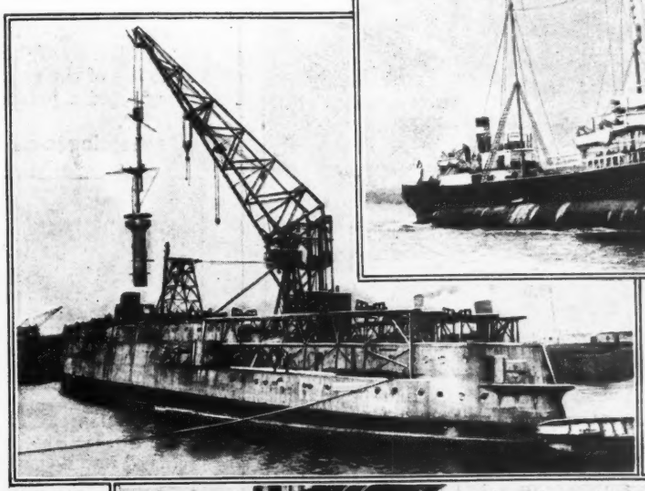
THE possibility of converting Uncle Sam's six uncompleted battle cruisers, designed for tremendous power and high speed, into a fleet of the fastest passenger liners afloat, not only has been suggested by leading engineers as a solution of the "scrapping" program, but has been demonstrated as practicable by Germany's success in transforming obsolete battleships into merchantmen.

German shipbuilders have proved that the process of conversion, even when a battleship has been completed, is comparatively simple and inexpensive. The ship is placed in drydock, and the heavy armor belt stripped from the sides. Turrets, guns, and fighting tops are cut away with oxyacetylene torches, and lifted out of the ship by great cranes.

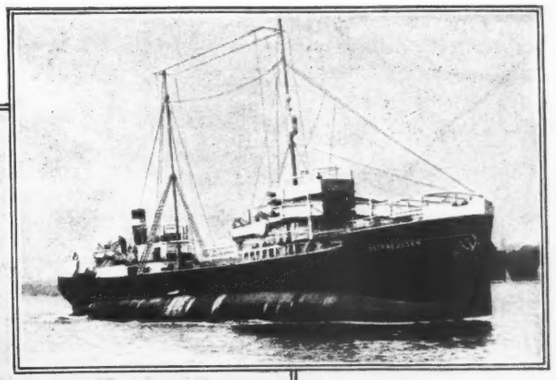
After the vessel has been completely stripped and lightened as far as possible, a vertical framework is bolted to the sides and covered with ordinary ship plating. This gives the converted vessel the usual appearance of the merchant ship, and the spaces thus made available are utilized for cargo. The propelling machinery is, of course, left intact.

The six American battle cruisers remain incomplete, and hence the superstructure above the waterline, say engineers, may readily be replanned for merchant service. Their enormous power plants, designed to give them speed of more than 33 knots as war vessels, would drive them at more than 25 knots as merchant ships, even with some of the boilers removed to reduce fuel consumption. Their great stability, required for firing big guns, would make the ships steady in rough weather and permit the addition of extra decks, thus providing passenger accommodations large enough to warrant the expectation of operation at a profit.

Below: Converting a German battleship into a merchantman. The crane lifts a fire-control mast



© K. & H.

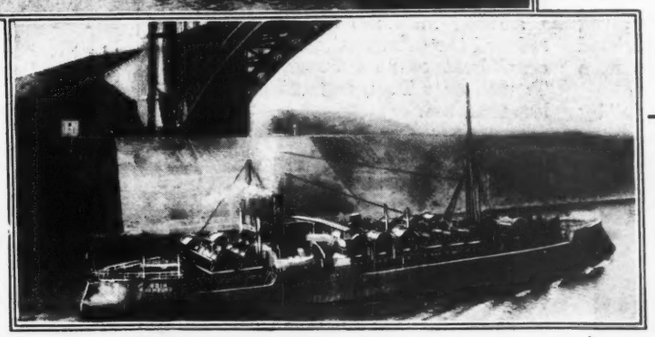


Above: The merchant ship Ostpreussen, built of two submarine hulls, completing a voyage from Texas to Hamburg, with an oil cargo

© K. & H.

The ingenuity with which the Germans have converted their obsolete submarines, that appeared at first to be absolute junk except for war uses, into a valuable commercial asset is demonstrated by the tanker *Ostpreussen*, which recently carried a cargo of oil from Texas to Hamburg. This ship was constructed by joining two submarine hulls in parallel, catamaran fashion.

A superstructure of the usual tanker form was built upon this curious under body to provide accommodation for the crew.



The steamer Odin, former battle cruiser, passing through the Kiel Canal with a cargo of locomotives

Useful "Scrapping"

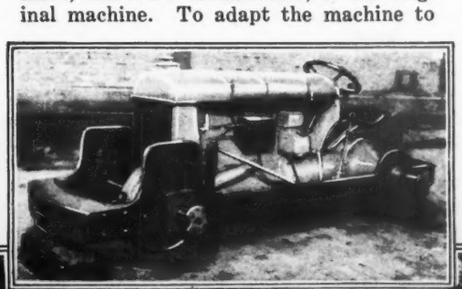
DELIBERATE destruction, under the naval disarmament agreement, of the great capital ships under construction for our navy is almost unthinkable. Engineers have estimated that the six newest type battle cruisers can be converted into 25-knot passenger liners, each capable of carrying 3500 passengers and 2500 tons of cargo and operating at a profit.

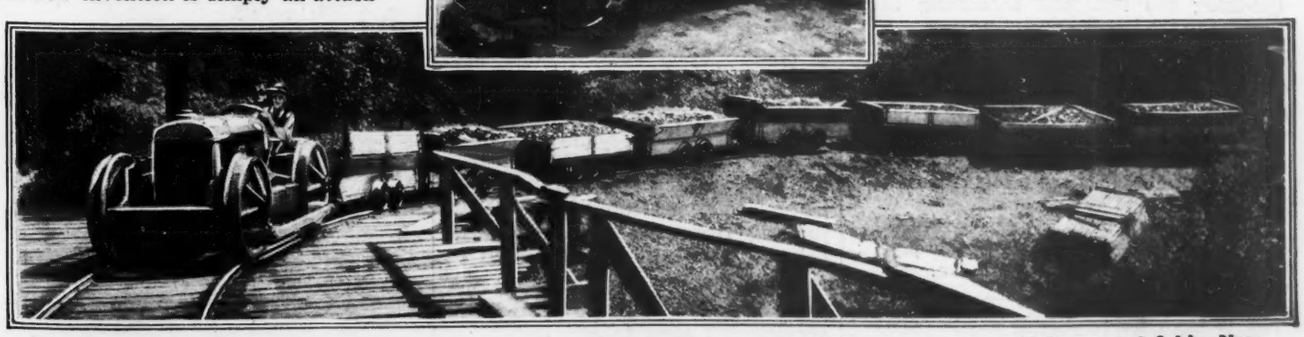
Farm Tractor-Locomotive Hauls Mine Cars on Rails

BY the addition of a heavy steel chassis and four locomotive type drive wheels, it is now possible to transform a light agricultural tractor into a locomotive to haul mine trains. In this new field, the tractor has proved unusually economical in operation and requires a minimum of head room.

The locomotive may be changed back into a tractor again in three hours, since the new invention is simply an attachment, and not a modification, of the original machine. To adapt the machine to rails, the tractor, with wheels removed, is set in a solid steel chassis or frame carrying two solid axles and automobile type brakes. With these exceptions, the frame unit is built along the standard lines of railroad rolling equipment.

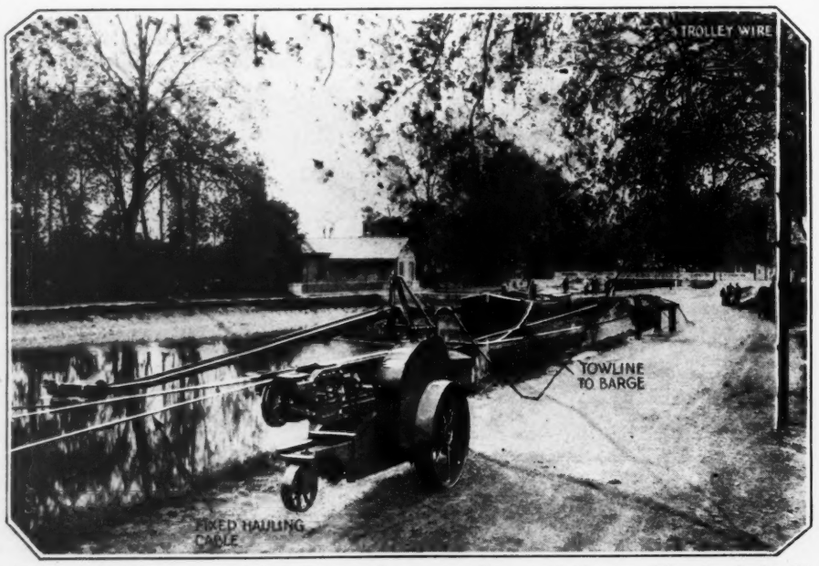
The rear axle is connected with the tractor transmission, preserving the three forward speeds and reverse. Power from the rear wheels is transferred to the front wheels by connecting rods.





Transformed into a locomotive, the light tractor is shown above hauling a train of loaded cars in an Alabama coal-field. Note the flanged drive wheels and connecting rod. The insert shows how the tractor is mounted in a steel chassis with solid axles

"Electric Mules" Haul Canal Boats



ENGINEERS, electrifying the canals of France, are experimenting with a system of self-hauling winches, or "electric mules." In utilizing this invention, a wire rope is fixed permanently along the bank of the canal and an overhead trolley wire is strung parallel to it, a little farther from the water.

The boat is attached to the "mule" by a towline, and the machine hauls itself along the rope, dragging a string of canal boats after it. The motor is run by electricity from the overhead wire.

Already machines of this kind have reduced the average time required for a canal boat to pass through the Foug Tunnel, near Toul, from 25 minutes to less than ten.

© Keystone

Mechanical Smoker Puffs, Saving Tongue Burns

BY breaking in a new pipe while the customer waits, and coloring "meerschaums" in off hours, a newly invented "smoking machine" is making profits for its inventor. The machine actually "smokes" the tobacco, drawing puffs slowly enough to prevent the pipe from becoming too hot, and consuming the tobacco to the last flake.

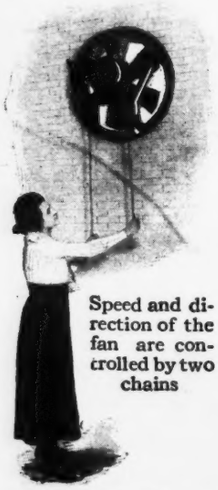
The mechanism consists of a small fan for exhausting the container—which is kept slightly below atmospheric pressure—and a revolving valve turned by a belt geared to the fan. The pipe is placed in the mechanically airtight mouth, and a switch on the front of the machine starts a motor.

The speed of smoking can be varied by turning the spindle above the pipe, which regulates the speed of the fan.

THE demand for turpentine requires 800,000 acres of virgin forest annually.

Speed Control for Fan Is Regulated by Chains

BY pulling one of two chains hanging from the motor of a newly designed ventilating fan, the direction of the fan can be reversed, and the speed varied from about 100 to 1170 revolutions a minute.



Speed and direction of the fan are controlled by two chains

The fan is equipped with a movable rocker arm to which the chains are attached. When one of the chains is pulled, the position of the brushes on the commutator is shifted. Since the motor is of the repulsion type, which insures sparkless commutation, this device gives complete speed control.

When the chains are approximately even, the rocker-arm ring is in the neutral position and the fan stops. Moving the ring in either direction will start the fan rotating.

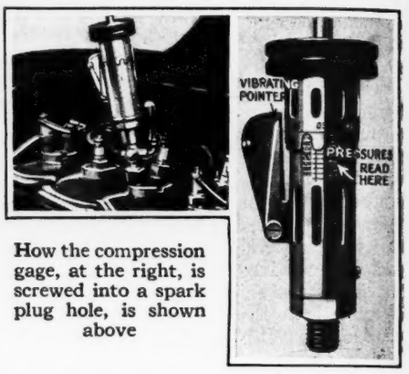
THE "Watch Washington" message broadcasted by POPULAR SCIENCE MONTHLY in the April issue was heard from coast to coast, judging from the response it received. You will be interested in reading further comments on the developments in government radio service—on page 4.

Gage Measures Pressure in Auto Engine

EXACT records of the compression pressures existing in an automobile engine while it is in actual operation can now be obtained by a pressure gage in which the inertia of the parts has been eliminated.

The gage is screwed into the spark-plug hole. Within the gage is a loose-fitting piston, the head of which is held against the opening leading into the cylinder by a powerful spring. Tension of this spring can be adjusted by tightening a vulcanite nut at the top of the gage. To the piston head is connected a pointer leading outside the indicator.

If the spring pressure on top of the piston



How the compression gage, at the right, is screwed into a spark plug hole, is shown above

is less than the gas pressure in the cylinder, the piston head will be lifted slightly at every compression stroke, and the tip of the pointer will vibrate. By turning the adjusting nut, the pressure of the spring can be made exactly equal to the compression, so that no movement of the pointer takes place.

As the barrel of the indicator is marked off according to the micrometer system, the compression pressure may then be read directly in pounds to the square inch in large figures marked on the side of the barrel, opposite the vibrating pointer.

Music Rolls Play Cornet while You Blow

MUSIC rolls for the cornet, with which any one can play this difficult instrument as readily as a player piano, have been invented by Private Jowett, a British soldier in the Army of Occupation on the Rhine.

The performer blows into the instrument, but the fingering and lip modulation are accomplished mechanically.

Fundamentally the invention is a tiny compressed-air player, with the lungs of the performer serving as bellows. Simply keep up a good wind pressure, and the instrument will play a selection with proper volume, tempo, and fingering as the music roll passes through it.

The Boy Who Gave Us Wireless

How Wealthy Young Inventor, with Homemade Apparatus, Discovered Radio's Marvels

[The story of Guglielmo Marconi who, among *Popular Science Monthly's* greatest contemporaries, was the youthful prodigy]

GUGLIELMO MARCONI, to whom the world is indebted for the wireless telegraph, was more fortunate than most inventors, for his father was a wealthy landowner near Bologna, Italy, where Guglielmo was born April 25, 1874. His mother was the daughter of a rich Dublin distiller. Consequently young Marconi did not lack money for a university education to fit him for difficult original research, or for apparatus required for experiments.

Guglielmo Marconi

Marconi's first invention was an indelible ink, made from wild berries with which he marked his clothes when he was five years old. His mother's lack of appreciation so discouraged the poor child that he essayed no more discoveries for 11 years.

Then, at the age of 16, he began experimenting with crude apparatus he himself had made to test the theory that electric current can pass through any substance and, if started in any given direction, will follow an undeviating course without need for a wire or other conductor. This discovery had recently been made by Professor Hertz. The boy soon verified the theory; then for five years he labored to turn it to practical account for transmitting messages.

In 1895 Marconi took out his first wireless patent in Italy. Theoretically he should have been able to transmit messages 20 miles; actually he could cover only two miles. Later, when he announced he had raised the limit to nine miles, he was ridiculed. Finding his native land was not interested, Marconi took his invention to England in May, 1896, where he won the enthusiastic interest of Sir W. H. Preece, head of the British Post Office Department. The first wireless message in England was across the Thames, a distance of 750 feet.

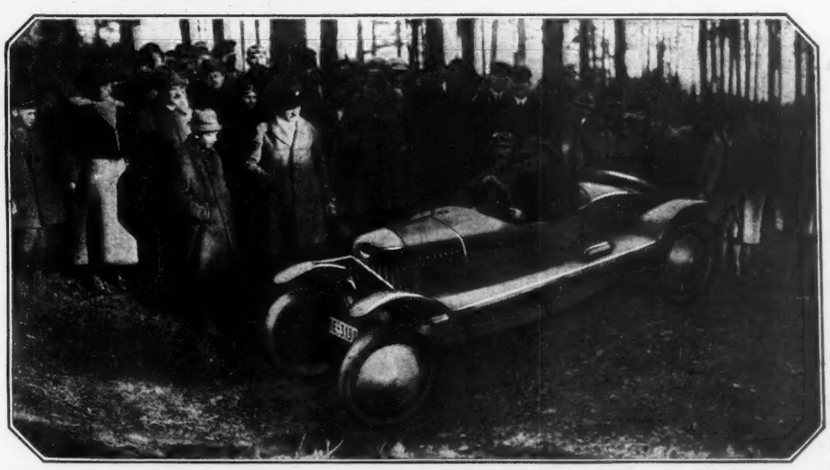
In June, 1897, Marconi sent wireless messages 12 miles; next year 32 miles. In that same year, 1898, 150 messages were exchanged between Queen Victoria on shore and the Prince of Wales cruising on the royal yacht, and 700 messages about a regatta were sent to a Dublin newspaper.

By the time he was 24, Marconi was world famous; but this ruffled his serenity no more than ridicule. He accepted success with perfect unconcern, as if he expected it. He was unassuming, deliberate, talked little, and was scrupulously neat and well dressed. With ample funds he went about his work, making steady and rapid progress.

The outstanding event in the evolution of wireless telegraphy took place at 12:30 P. M., December 12, 1901, when Marconi, seated in a little shack on Signal Hill at St. John's, Newfoundland, heard the letter "S" repeatedly sent by prearrangement from Poldhu, Cornwall, on the other side of the Atlantic. Developments followed rapidly. In 1908 transatlantic radio stations were opened for business. In 1914, the principal nations enacted laws requiring passenger ships to carry wireless equipment and operators. In 1905, wireless telephone messages were sent from Washington to Paris, 3700 miles; and Washington to Honolulu, 5000 miles.

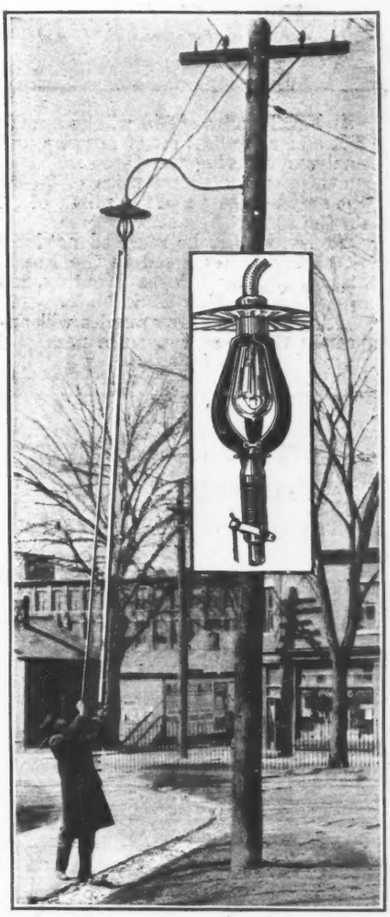
Now, thanks to Marconi, 15 per cent of international communication is by wireless. Wireless telephony, too, is making extraordinary progress. There are 50,000 amateurs in the United States alone.

One Cylinder Car Is with Us Again



THE one-cylinder automobile is coming back. The designers of this new car have turned to a single cylinder engine of about 12 horsepower in an effort to reduce fuel consumption. Streamlining has been adopted on the body and beneath the car to reduce air resistance. The car can attain a speed of 20 miles an hour.

Long Pole with Jaws Replaces Lights



REPLACING burned-out electric lights in signs high above the roofs of skyscrapers or in lamps at the top of tall poles has become a quicker and safer task since the perfection of a simple replacing device for lamps installed in push sockets. The invention consists of an aluminum clutch mechanism mounted on the end of a jointed wooden pole of any required length.

The jaws fit around the base of the bulb, and are opened by pulling a cord. By gradually releasing the tension cord, the jaws take a firm grip on the glass without any danger of breakage. With the push type of socket the new bulb is thrust directly into place, but where the screw type is in use, the pole must be rotated.

Suits of Rubber Sponge Keep Aviators Warm

CLOTH of rubber sponge, similar in structure to the familiar bathroom article, is now being used for aviator's suits for high altitude duty. Since rubber sponge is a mass of air cells with thin rubber walls, it provides an almost perfect insulation against heat.

The impervious rubber makes the clothing windproof, and the air cells retain the bodily heat of the aviator even at an altitude of 30,000 feet.

Thin layers of this cloth are said also to make telephone booths soundproof when inserted between the double walls, since the rubber will not transmit vibrations. Another odd use of the material is found on the baseball diamond, where the big league catcher often slips a thin sponge into his mitt, to protect his hands.

When Can You Interchange Hands of a Clock?

Best Solutions to Sam Loyd's Puzzles Win $25 in Prizes

A FIRST prize of $10 will be awarded for the best set of answers and analyses covering the three problems on this page; a second prize of $5 for the next best set; and ten prizes of $1 for the 10 next best sets.

Answers must be received not later than May 1, addressed to the Puzzle Editor, Popular Science Monthly, 225 West 39th St., New York, N. Y.

Answers to the May puzzles will appear in the June issue; the names of prize-winners in August.

What Time Was It When the Alarm Rang?

THE boss mechanic set his alarm clock for eight o'clock, but as shown in the illustration, it summoned him at either a little after five, or about 25 minutes past 12.

We cannot tell the hands apart, and it is one of those rare moments when the hands might be reversed in their positions and yet tell the correct time.

Such positions occur very infrequently. For example—if at six o'clock we transpose the hands, it would put them in positions' that would be inconsistent with the regulations of a true-running timepiece, for while the minute hand was proceeding to the half-hour point, the hour hand would have gone 2½ minutes away from number 12.

As far as the true running of this clock's mechanism is concerned, what, exactly, are the two times indicated?

Correct Solutions to Previous Puzzles

[As a convenience to readers, correct solutions to Sam Loyd's puzzles that appeared in the January, February, and March issues are printed below. Answers to the April and May puzzles will appear in the June issue.]

January Answers

FENCING THE TOWN

Let X miles equal length of one side of small square. Then—$5X^2$ equals 12X, and X equals 2 2/5 miles. Therefore, the perimeter of the cross must be 28 4/5 miles, and the town's area 28 4/5 square miles.

FROM SPHERE TO WIRE

Since the contents of a cylinder, with diameter and length equal, are 50 per cent greater than the contents of a sphere of similar diameter, the sphere with a diameter of 24 inches is, for the purpose of calculation, converted into a cylinder 24 inches in diameter and 16 inches in length.

Now, as a wire is but an extended cylinder, we find by comparison of the squares of the diameters, that 5,760,000 of the little cylinders (1/100 of an inch in diameter) 16 inches in length, are contained in the large cylinder, 24 inches in diameter and 16 inches in

(*Continued on page 80*)

What Charge for Sawing These Logs?

DENNIS had sawed a cord of soft wood and pocketed $2.40. Then he tackled a cord of hard wood, at the same rate an hour for his labor, and he is here calculating his prospective earnings, for there are certain data to consider in working out his estimate.

A cord consists of logs piled four feet high, four feet wide, and eight feet long. Dennis was required to cut his logs into 16-inch lengths. The first cord was four-foot logs, but the hard wood logs were eight-foot lengths. To saw this hard wood, Dennis found, took three times longer than to cut the soft logs,

How much will Dennis have to be paid for cutting that second cord?

Prize Winners in January Contest

FIRST PRIZE, Ten Dollars: **Francis M. Weston, Jr.**, U. S. Naval Air Station, Pensacola, Fla.

SECOND PRIZE, Five Dollars: **Walter D. Emerson,** Orono, Maine.

The TEN ONE - DOLLAR PRIZES: W. H. Myers, Jefferson City, Mo.; Baldomero Lacruz, New York City; Addie R. Vosburgh, Oakland, Calif.; Ernest K. Chapin, Muskegon, Mich.; O. Phelps Meaker, Cambridge, Mass.; Eugene A. Keller, Takoma Park, D. C.; B. H. Walter, Mason City, Ia.; W. V. Lovitt, Colorado Springs, Colo.; Harmon S. Boyd, Woodbury, Conn.; Chas. H. Van Nest, Orlando, Fla.

Honorable Mention

Solvers who are deserving of special commendation for their work in Sam Loyd's January puzzle contest include:

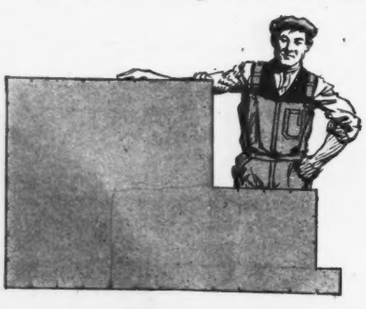
Emory E. Colwell, Providence, R. I.; Frank Williams, Dayton, O.; A. G. Douglas, Ottawa, Ont., Can.; Howard Kaster, Berkeley, Calif.; Bart Kaiser, Prague, Okla.; J. Robinson, North Shields, England; J. E. Flexner, Huntington, W. Va.; Lester M. Rice, Canton, O.; L. M. Merrill, Glendale, O.; Henry H. Snyder, Seattle, Wash.; Claude C. Prater, Springfield, Mo.

Maurice P. Whitney, Elmira, N. Y.; Leslie H. Mann, Brooklyn, N. Y.; F. Duncombe, Erie, Pa.; W. H. Elkins, Topeka, Kan.; Fred. E. Haubold, Bartlesville, Okla.; A. C. Williams, Ardmore, Pa.; E. R. Hunter, New Brighton, Pa.; Charles Marti, Detroit, Mich.; Preston V. Carnette, Swarthmore, Pa.; Mrs. R. E. Shore, Lemoore, Calif.; Edith A. Garlock, Hilton, N. Y.; W. H. Inman, Washington, D. C.; Daniel A. Fuchs, Buffalo, N. Y.; D. E. Pennington, Buchanan, Ga.; Lincoln D. Hatch, Brookline, Mass.

A. L. Lincoln, N. Y. City; Mrs. Geo. W. Sykes, Newport, Ark.; K. J. Adasiewicz, Orchard Lake, Mich.; Emil H. Hart, W. Lynn, Mass.; Steve Flesher, Houtzdale, Pa; L. B. Smith, Hershey, Pa.; Geo. Premer, Chicago, Ill.; Austin P. Baldwin, Columbus, O.; H. H. Svanoe, No. Milwaukee, Wis.; Drew MacDouga , Nichols, Iowa; W. Holland, Winnipeg, Can.; Jacob Thiessen, Addington, Okla.; Nathaniel Myers, Swarthmore, Pa.; Charles S. Smith, Oakland, Calif.; E. Tabor, Upper Lake, Calif.; Miss Jean B. McCall, San Pedro, Calif.

H. O. Bumann, Savannah, Ga.; A. H. Candee, Milwaukee, Wisc.; G. W. Seaburg, Boston, Mass.; C. H. Teague, Gladstone, Mich.; H. G. Taylor, San Antonio, Tex.; Philip W. Robinson, Boston, Mass.; Evan Bordahl, Roslyn, S. D.; C. E. Mears, Baltimore, Md.; William Bach, Chicago, Ill.; J. E. Frazer, Richmond, Ind.; Walter T. Gorton, Springfield, Mass.; B. J. Fenton, Oneida, N. Y.; C. C. Meredith, Moatsville, W. Va.; Frank M. Libbey, W. Somerville, Mass.; Frank Turpie, No. Platte, Neb., A. Pelletier, Montreal, Canada; W. H. Ahl, Newark, N. J.; Walter Freshman, Butte, Mont.;

How Many Pieces in This Sheet of Metal?



THE metal worker had to build the irregularly shaped piece, shown in the sketch, from the parts of a dissected square, and without wasting or discarding material. It was no easy job, as you can see.

Now, if that original 9 by 9 square was dissected into the fewest possible number of parts that would admit of being grouped into the piece the workman shows, let us see who can indicate on the sketch the division lines of the joined parts.

How Cable Guides Airplane Pilots at Night

BY modifying his famous system of piloting ships by means of a submerged cable through which an alternating current passes, creating a magnetic field, Lieut. William Loth, a French aviator, has perfected a method of guiding airplanes through clouds and at night. The invention has already been investigated and approved for use by the operators of a commercial air line between London and Paris.

The airplane guiding cable is stretched above ground and between posts.

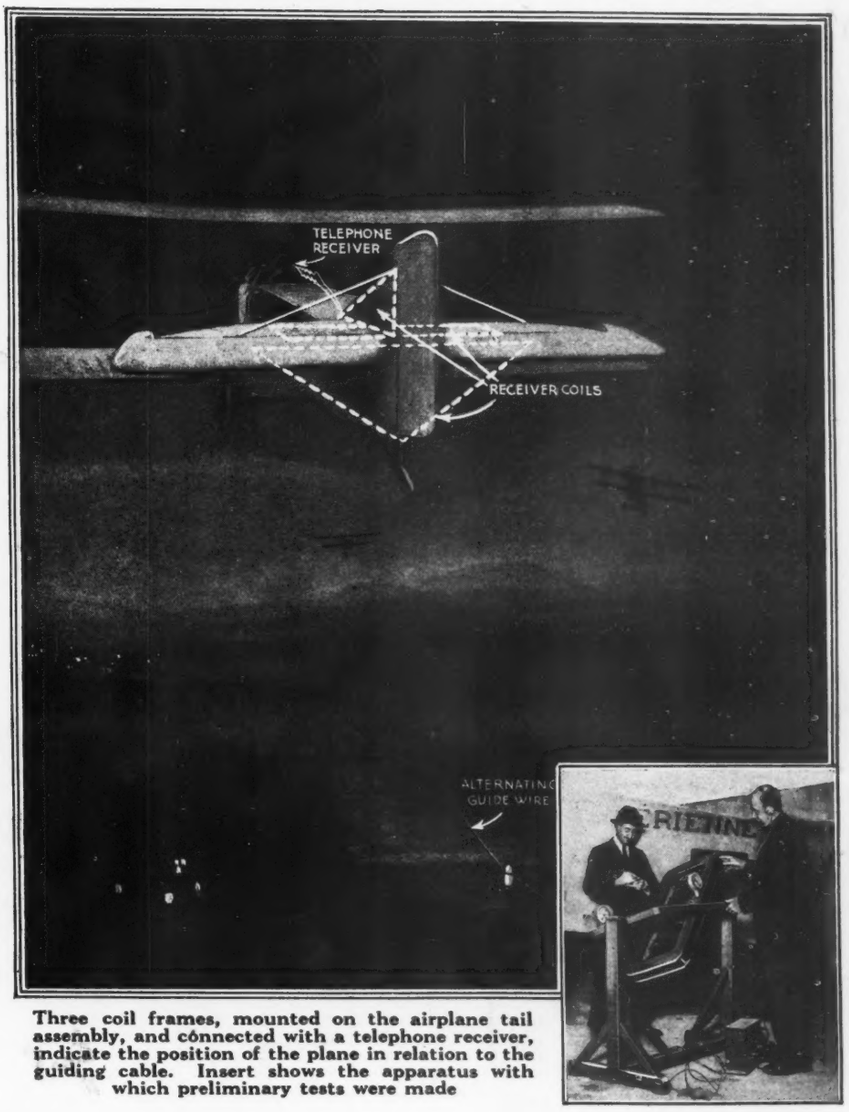
In studying the lines of force of the magnetic field surrounding the cable, the inventor used an apparatus consisting of a frame wound with an induction coil and mounted like a ship's compass. The induction coil may be connected either with a telephone circuit or a galvanometer.

Aviator Tests Magnetic Field

By a series of tests, Lieutenant Loth ascertained that the induction in the coil practically ceased when the plane of the frame forms a tangent to the lines of force of the field. In that position the sound in the telephone receiver is almost inaudible and the galvanometer shows only a minimal deviation.

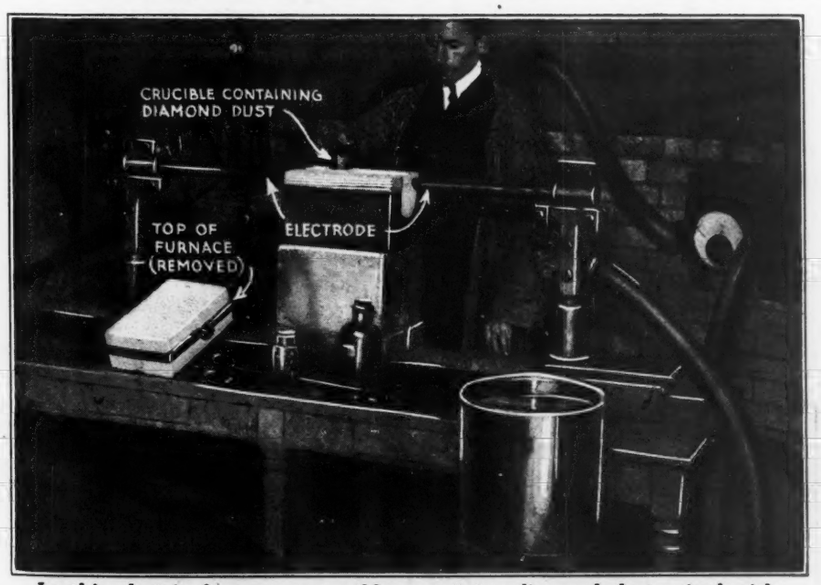
Having ascertained the form and extent of the magnetic field of the cable, the inventor mounted three frames, wound with copper coils, on the tail of an airplane. Two of these coil frames are vertical, one longitudinally, the other at right angles to the airplane's longitudinal axis. The third frame is placed horizontally and also at right angles to the longitudinal axis. The two vertical coils locate the direction of the cable; the horizontal coil searches it while the airplane is at great height. The sounds are received by a telephone circuit.

When the line of flight is parallel to the line of the cable, the pilot hears the maximum sound through the vertical longitudinal coil. If he crosses the line, the sound becomes weaker. By following the varying intensity, the pilot can make a safe landing in the darkest night.



Three coil frames, mounted on the airplane tail assembly, and connected with a telephone receiver, indicate the position of the plane in relation to the guiding cable. Insert shows the apparatus with which preliminary tests were made

Realistic Diamonds Manufactured from Chips and Dust



In this electric furnace, a crucible containing diamond dust mixed with secret chemicals is heated. The heat releases mercury, cementing the particles

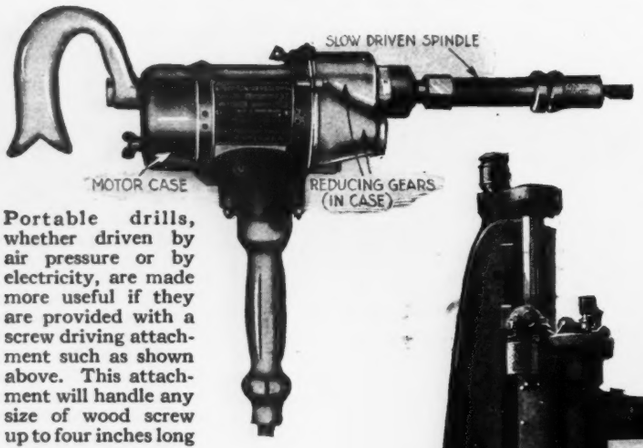
A PROCESS of creating diamonds by fusing a mass of diamond dust and chips into large artificial stones that only an expert can distinguish from the natural gem, is the recent discovery of a German chemist named Van Bolton.

The chips and diamond dust, formerly used only to polish other gems, are put in a little carbon crucible and mixed with a chemical or a combination of chemicals that will release mercury vapors when heated. This crucible is heated in an electric furnace, where it remains for weeks, and sometimes for months. During this time the mercury percolates through the diamond dust and is said to cement the particles together.

When the crucible is opened, its contents have changed into a solid black mass that is instantly plunged into ice cold water. The product is then cleaned—and the result is said to be a rough diamond that is cut and polished in the usual way.

This process of fusing gems has caused consternation in the diamond trade, it is reported, because of its close imitation of the natural stone.

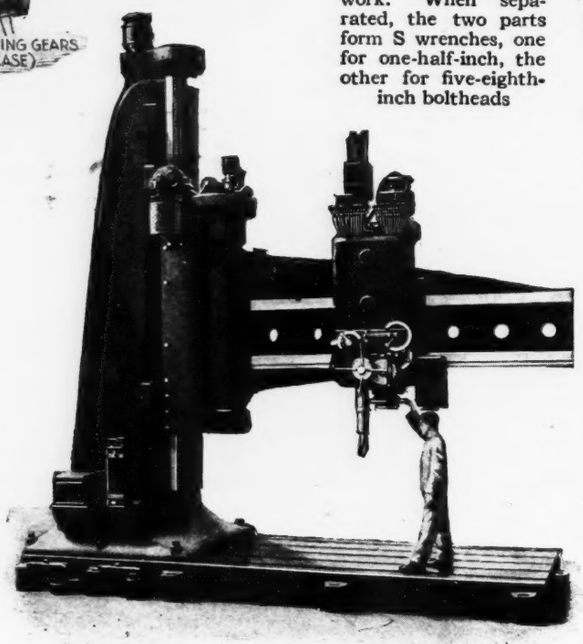
Huge Radial Drill Bores Hole Four Inches Wide



Portable drills, whether driven by air pressure or by electricity, are made more useful if they are provided with a screw driving attachment such as shown above. This attachment will handle any size of wood screw up to four inches long

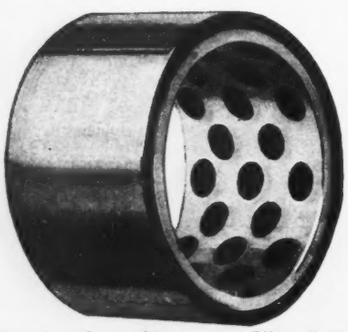
This combination tool, in its assembled state, forms eight-inch pliers with strong, toothed jaws suitable for pipe work. When separated, the two parts form S wrenches, one for one-half-inch, the other for five-eighth-inch boltheads

As the thimble of this micrometer gage is turned, the indicator shows the number of one thousandths of an inch between the moving rod and the fixed anvil of the gage

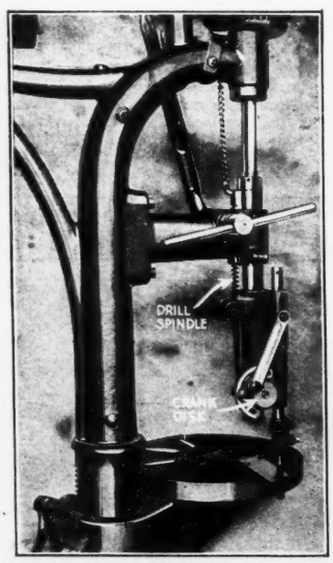


This gigantic radial drill will bore a hole four inches in diameter and 20 inches deep. Its movable arm can be raised nearly 10 feet

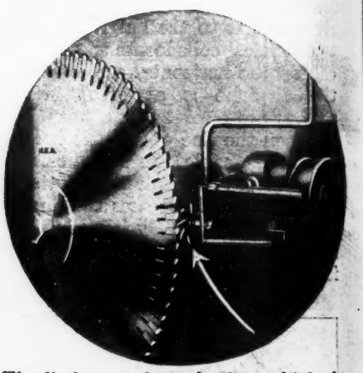
If connected with a winding machine, this revolution counter will register the number of turns of coil wound on a magnet. The connection is made with a flexible shaft



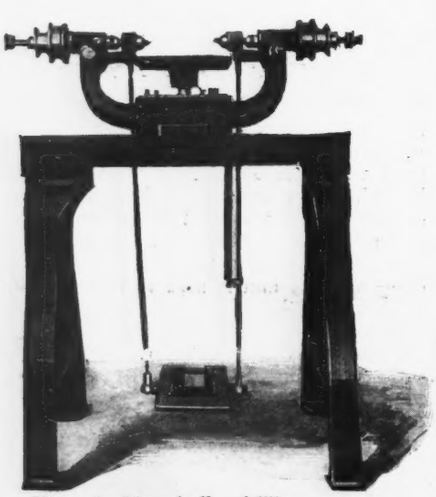
Lead and graphite paste, filling holes in the bronze casing, lubricate this type of bearing



Changing the spindle's rotating motion to reciprocating motion, this attachment transforms the drill press into a filing machine

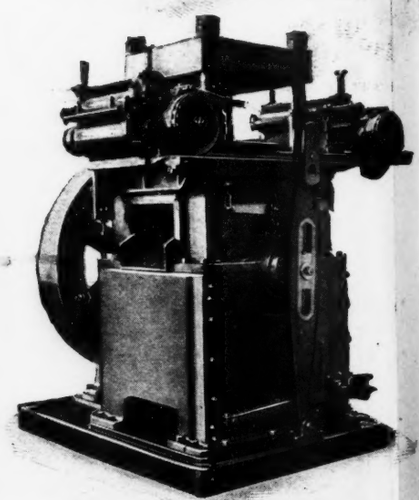


The little sprocket wheel to which the arrow points removes any chips from between the teeth of the saw



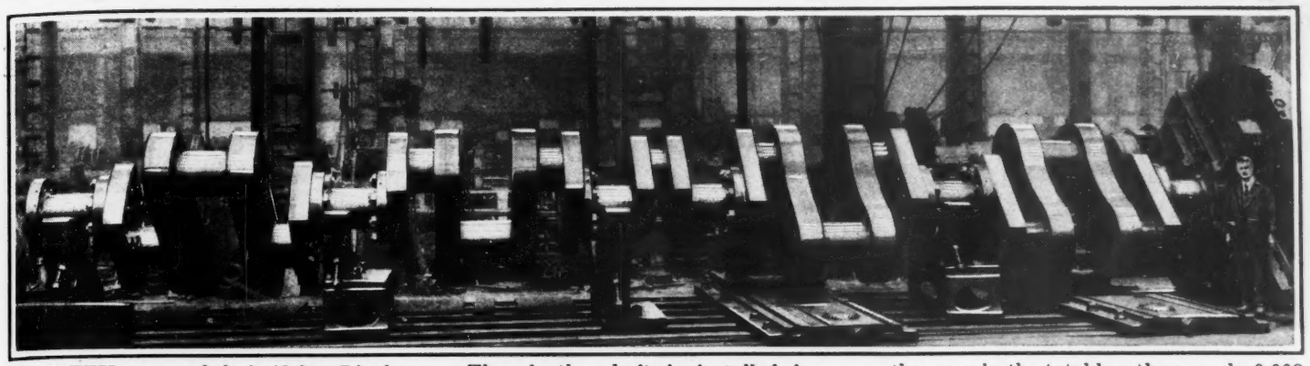
This double-spindle drilling machine drills holes in the same object simultaneously in opposite directions

AS a special service to readers, the Editor will be glad to supply the names and addresses of manufacturers of devices mentioned in POPULAR SCIENCE MONTHLY.



Two of the outstanding features of this vertically working die press are its safety and the accessibility of its tool carrier

Forty-Two-Foot Crankshaft for Diesel Engine Marvel of Accuracy



A FIFTY ton crankshaft 42 feet 7 inches long, with 12 throws, has just been machined in England for use in a marine engine of the Diesel type.

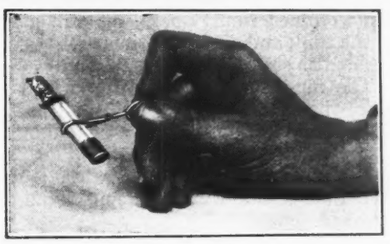
Though the shaft is installed in one piece, it is composed of four sets of cranks, each of three throws, connected with flanged coupling shafts. In spite of its size, the error in the total length was only 0.008 of an inch, and the largest error in the alinement of the journals was only 0.0012 inch—almost incredibly accurate.

Airplane Altimeter Is Useful to Motorist

THAT an airplane altimeter is an extremely practical accessory for a motorcycle is the discovery of John Edwin Hogg, of Los Angeles, Calif., who tours extensively in the mountainous sections of the Western states over roads that range from 280 feet below sea level to elevations of 12,000 feet.

There is much variation in the functioning of a gasoline motor in negative and positive elevations, and the altimeter, mounted on the top of the toolbox, under the eye of the driver, supplies useful information.

In conjunction with the speedometer, the altimeter is also used to determine the gradient of mountain passes. As a barometer, it is also useful in enabling the tourist to forecast weather conditions.



Smoke Down to the Last Puff with New Holder

CIGARETTES can be smoked down to the cork tip or even farther, with a diminutive new holder consisting of a twist of wire about the size of a small hairpin.

The cigarette is placed in a small loop, and held there by a ball-shaped catch at the free end of the loop. The catch slips behind a wire handle, where it fits into a bend in the wire. A larger loop provides a grip for the fingers.

THE head of the common shark is full of a glue of a highly valuable quality.

Photo Can Be Reprinted without a Negative

MAKING photographic reprints without negatives, directly from a print, is now possible for amateurs with the invention of a printing paper that develops a positive image and that is acted upon by light reflected from the original print. You can make any number of copies from an old print in your album, even if the negative has been lost, declare the inventors. Similar paper can be used in the camera, and a positive print obtained without a negative at all.

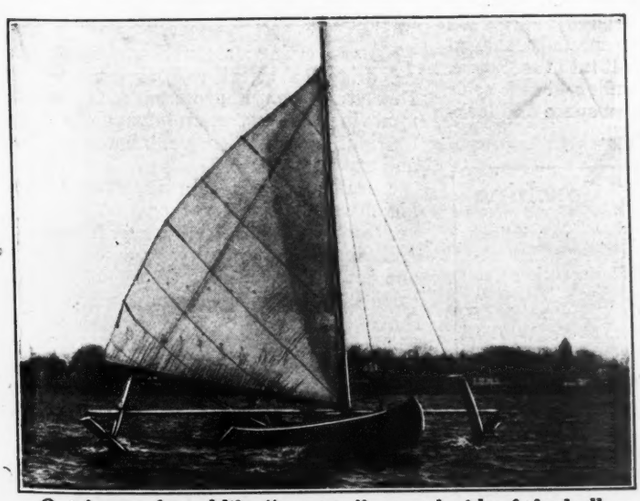
The printing outfit consists of a collapsible lightproof box with a lens set into a partition in the center. The picture to be copied is placed against the end of a larger compartment, and illuminated by two 25-watt electric lights, while the sensitized paper is inserted into the end of the smaller compartment.

This arrangement practically converts the printer into a camera, since the print paper is as sensitive to light as a negative.

From one print any number of copies can be made with this camera

At Last—A Sailing Canoe that Won't Upset

A SAILING canoe that will not heel over, even in a fresh breeze, and in which the danger of capsizing has been eliminated, is the invention of the McIntyre Brothers, yachtsmen of New Rochelle, N. Y. Their patented design embodies a new departure in racing models that depends for stability upon an outrigger instead of ballast or a weighted keel. In fresh breezes the inventors claim their craft will outdistance anything on the water except motorboats. The canoe carries 600 square feet of canvas. This would be impossible except for two outriggers shaped like waterplanes, set 15 feet on each side of the hull. These planes offer practically no resistance to forward motion; but their lateral resistance is great. They are placed at a carefully calculated angle, which brings more surface into the water as the boat starts to heel over, giving the canoe a beam of 30 feet. This checks heeling altogether and sets the full energy of the wind to driving the ship forward.



Outriggers shaped like "scooters" on each side of the hull keep the canoe from "heeling" or capsizing in a stiff breeze

Ship Sets Non-Stop Record

THE world's record for a non-stop run by a motor ship is believed to be held by the *Lobos*, a 9000-ton freighter of the Pacific Steam Navigation Company, which steamed from Liverpool to Bahia Blanca—a distance of 6527 nautical miles, the journey occupying 25 days—without stopping her engines.

Exhumed Car Still Runs under Own Power

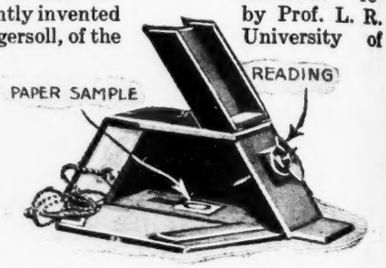
A RECEDING flood in San Diego, Calif., disclosed recently what appeared to be the useless wreck of an automobile that had been washed away and buried by the flood of 1916.

All the wooden parts had rotted away, but when it was taken from the mud, the workmen found there was still gas in the tank and air in the tires and they decided to see if the car would run.

The mud was washed away with a hose, the spark plugs cleaned and new oil supplied—and the car is now making exhibition runs, demonstrating that a light car of this model will withstand incredible abuse without being totally wrecked.

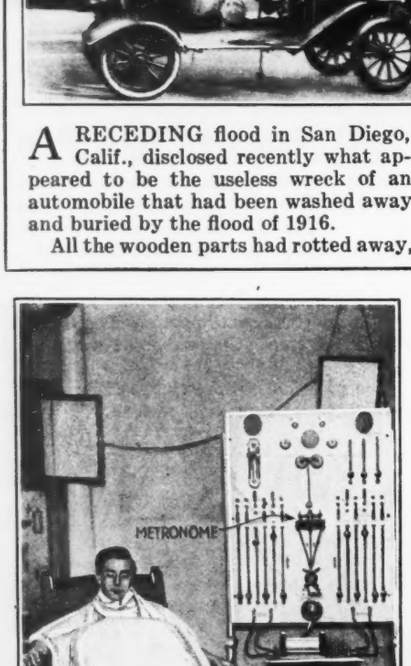
Glossiness of Book Paper Measured Accurately

THE proportion of polarized light in the glare reflected from book papers is a basis for measuring the glossiness of finish in a new instrument recently invented by Prof. L. R. Ingersoll, of the University of Wisconsin. Papers that are too glossy are hard on the reader's eyes, yet a smooth finish is essential for fine illustrations.



This instrument measures the proportion of polarized to ordinary light reflec ed from paper

The effectiveness of the instrument is based on the fact that the glossier a sheet of paper, the more it will polarize the light that strikes it. The light falls upon the sample at an angle of 57 degrees, and the proportion of polarized to diffused (or ordinary) light reflected from the surface is analyzed with an improved polarimeter.



You Can Exercise as You Sit in Your Easy Chair

BY the use of an induction coil with electrodes to stimulate the muscles, vigorous exercise can be taken while you sit in your easy chair. In a flesh reducing system recently devised, the patient reclines in an electrified chair covered with warm, wet towels to obtain a good electric contact over large surfaces of the body. Other electrodes are attached to the arms and legs.

At regular intervals, from 20 to 30 times a minute, the patient receives a weak but perceptible shock from a high-tension electrical induction coil. This causes the muscles of the entire body alternately to expand and contract.

To make and break the current in the coil at regular intervals, an interrupter much like a metronome has been utilized. This swings back and forth, making contact each time it passes the center.

Metallic Filler Renews Cylinder Walls

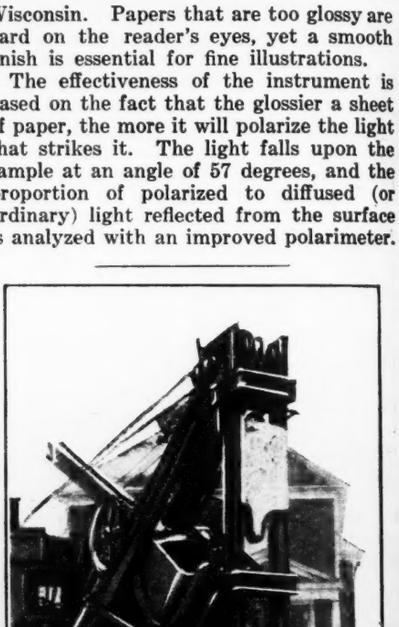
SCORED cylinder walls may be made as good as new without reboring, says R. D. Heacox, of Washington, D. C., inventor of a new process that applies a metallic filler to the cracks and amalgamates with the cast iron cylinder walls.

Preheating is declared unnecessary when cracked water jackets and scored cylinders are repaired by this process. A dovetail slot is cut into the cylinder wall where it is cracked. The filler is melted and spread upon the walls with a specially shaped soldering iron that forces it into the groove. Here it unites with the walls and as it cools it expands, filling the worn space and locking itself into the dovetail.

Radio Stations Combine

COMBINATION of two wireless broadcasting stations—the Westinghouse Electric & Manufacturing Co. station at Newark, N. J. (WJZ), and the station of the Radio Corporation of America at Roselle Park, N. J. (WDY)—will be an important radio development of the next few weeks. The combined station will be located on Broadway in the heart of New York City.

With broadcasting stations and programs continually changing, our Information Department supplies the latest facts about radio to readers who send inquiries in self-addressed envelopes.



Steam Shovel-Pile Driver Removes Pavement

BY converting a steam shovel into a pile driver, a street railway company in Detroit, Mich., improvised a method of removing a heavy concrete pavement from its right of way with a minimum of time and expense.

A framework of steel rails, about 18 feet high, was bolted together and attached vertically to the derrick boom of the shovel. A sliding weight was arranged to move up and down inside this frame, lifted by a wire cable that had been disconnected from the shovel, yet was operated by the shovel winch.

A "war nose" was fitted to the bottom of the sliding weight, and this shattered the concrete into pieces so small they could readily be removed with a shovel.

The steam shovel moved along under its own power, since by raising the boom slightly, the improvised pile-driver frame could be lifted clear off the ground.

Explorer Finds New World's Largest Diamond

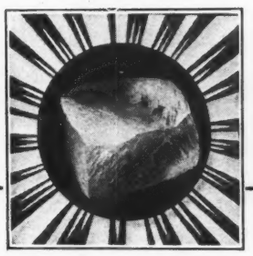
Young Adventurer Penetrates Mysterious Depths of British Guiana Jungles, where Death Lurks and Gleaming Gems Lure

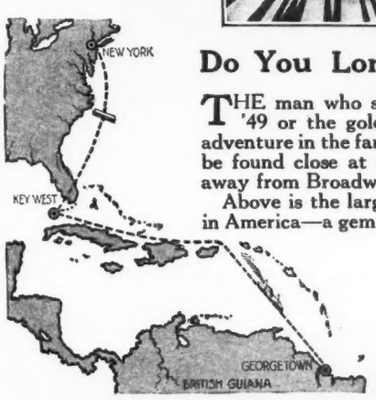
WILL British Guiana become a second Klondike? Do the tropical, fever-haunted jungles in northeastern South America rise from a soil rich in diamonds and gold—hiding wealth and treasure for men strong and adventurous enough to dare the wilderness?

"Yes," answers William J. LaVarre, 24-year-old explorer, who has just found the largest alluvial diamond ever mined in the Western Hemisphere—a gem about an inch square and half an inch thick, weighing 31 carats.

The value of this jewel is so great that when LaVarre returned to New York recently, the police discovered he was constantly being shadowed by a band of hold-up men intent upon robbery. The diamond was placed in a vault for safekeeping.

In its issue of last December, POPULAR SCIENCE MONTHLY included LaVarre in a list of explorers who were pushing out to lift the veils that still enshroud the world's few unmapped and unknown regions. He is one of the first to return. From an interior wilderness, of which practically nothing was known to the outside world save the courses of the rivers, and where native rumors hinted at the existence of diamonds, he has brought glittering proof of marvelous hidden treasure.





Do You Long for Adventure?

THE man who sighs for the stirring days of '49 or the gold rush of 1898 needn't seek adventure in the far corners of the globe. It is to be found close at hand—less than a fortnight away from Broadway!

Above is the largest diamond ever discovered in America—a gem of 31 carats, picked up in the jungles of Guiana by a young explorer, William J. LaVarre. Six months ago *Popular Science Monthly* announced his departure on the treasure hunt from which he has returned with the fascinating story he tells here.

Riches that Rival South Africa's

For years LaVarre has been noted as an intrepid explorer. Recently he has proved himself to be an expert mineralogist and geologist. After four expeditions into the tropical interior of little-known Guiana, in which he carefully surveyed and studied the diamond resources, he declares that if the fields prove as productive as his preliminary prospecting indicates, Guiana will become one of the world's richest mineral regions, and the diamond mines of South Africa will cease to monopolize the markets.

"An adventurer can win a fortune from the earth in British Guiana," said Mr. LaVarre, "if he goes in properly prepared. I made my first trip up the Mazaruni River when I was only 18 years old, and it netted me $20,000 in three months. But—a man must have adequate funds. He must know something about diamond prospecting, and, most important of all, he must be able to stand the rough life and the rigors of the terrible climate.

"A man with a stake of $5000 and the courage to stick at the work ought to make good. It costs about $1000 a month to outfit and maintain an expedition, which consists of a party of nearly 25 natives. As for the climate, the heat and humidity are intense. The greatest danger lies in an attack of jungle fever. Because of the clouds of mosquitoes always buzzing about the party, day and night, this is a constant menace.

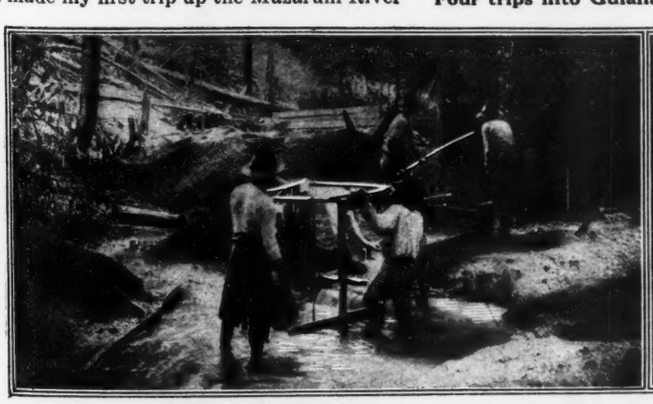
"Three of the four white companions who have accompanied me on my trips are dead. The fourth is now seriously ill in a New York hospital. I believe that no white man can stay in the jungles more than five months at a time. I have had the fever three times myself, and once nearly died. But I did find diamonds!"

William J. LaVarre, diamond prospector. Four trips into Guiana made him wealthy

Perils Menace Diamond Seeker

To reach the diamond fields of British Guiana, the explorer travels up the Mazaruni River with native boats, much like large canoes, manned by 20 paddlers. From four to five weeks of paddling are required to reach the best diamond fields, for while the distance is not great, the river is treacherous and full of rapids. There are stretches said to be as dangerous as the famous White Horse Rapids in the Yukon, where many gold-seekers of the Klondike rush were wrecked. The Mazaruni is ascended by poling and towing. Often the crew must stand knee deep in the stream and haul the boat over the narrow, shallow bars by hand.

After arriving at the diamond fields, a permanent camp is pitched, with every possible sanitary precaution, in the midst of a thick tropical jungle, and the explorer sets his party to digging a well about 60



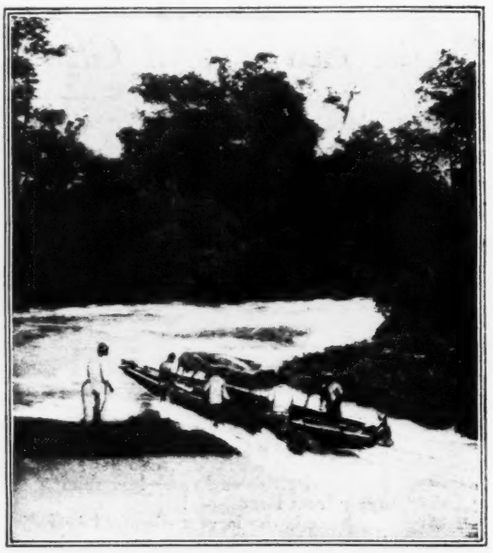
From the well in the background is pumped the "yellow earth," which, when cradled, yields diamonds and gold

Penetrating treacherous jungles, the explorer is accompanied by half-savage natives armed with blowguns

feet deep. This pierces the soil and vegetable humus on the surface of the ground, and reaches into the "yellow earth" in which diamonds are found. The yellow earth is a decomposed rock, about the consistency of sand, so that, when water is pumped from the well, the sand, water, and diamonds come up together, and settle in crude troughs. The flow of water gradually carries away the lighter substances, leaving diamonds, gold, and other minerals—usually tin—in the bottom.

As yet diamond mining in Guiana is done by the placer method, similar to that used in mining gold in the early days of the '49 rush in the United States. Gravel from the bed of streams is sent through "jigs" and cradled, or even "panned" by whirling a mixture of earth and water with a peculiar centrifugal movement in a broad, flat iron dish. The success of these methods is due to the fact that diamonds are heavier than common stones, and that they will stick to a strip of greased leather while quartz pebbles will not. The gems are tested by pressing them between two blades of a knife. If they do not collapse, they are real.

Like placer gold, all diamonds found in rivers must have been washed out of the "mother lode" or diamond pipes by the rain, and washed into the streams. In consequence, the diamonds found are small, and the prospectors use alluvial mining to pay expenses while they search the mountains and the flats for "blue dirt"—the hard, blue clay that once filled the crater of a volcano, and in which the heat and pressure caused the diamonds to crystallize. Whoever finds one of these pipes—and they undoubtedly exist—will break the diamond monopoly of the DeBeers Syndicate and become one of the world's rich men.



On the Mazaruni River, in the tropics of British Guiana, LaVarre encountered some of the most treacherous rapids to be found anywhere in the world

"During the last year 150,000 carats of diamonds—worth about $15 a carat—were found in British Guiana," Mr. LaVarre reported. "Most of them are too small for jewelry uses, but are valuable for industrial purposes, in the manufacture of drilling and rock-boring machinery. My 31-carat find was an exception, but it proves that the larger diamonds are there.

"The government allows the prospector to stake out a five-acre claim and work it for five or ten years, and when I start on my fifth expedition to the interior I expect to install modern placer mining machinery and tackle the job of winning diamonds from the jungle in a businesslike way, while I continue the search for the actual diamond pipes."

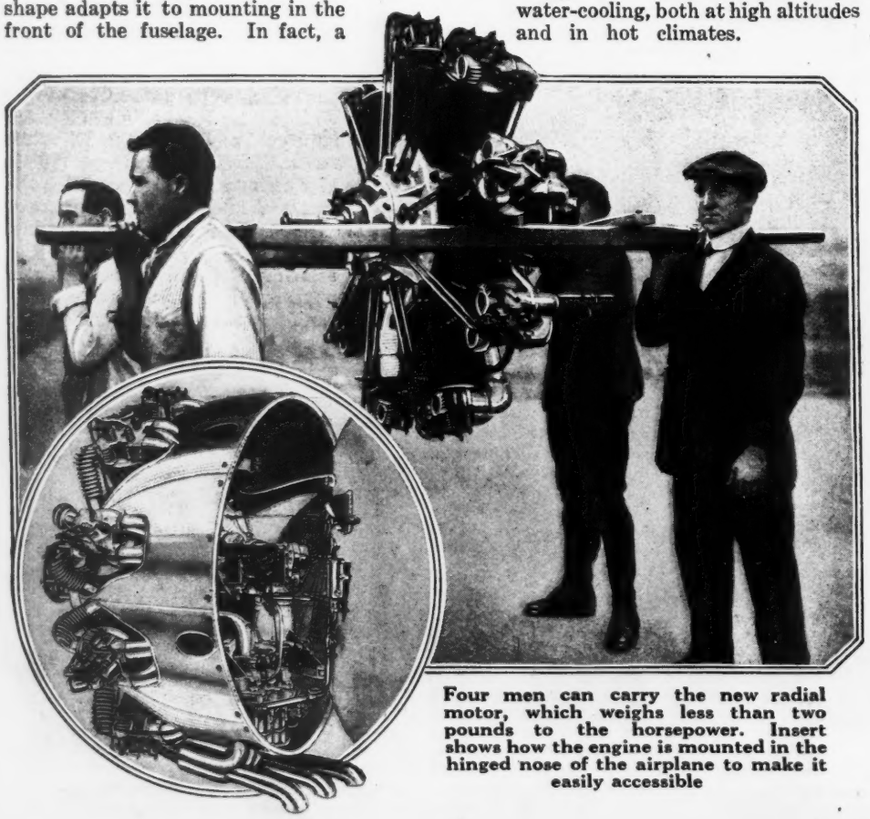
Airplane Carries Engine in Hinged Nose

AMAZING lightness and reliability have been obtained in a new 400-horsepower air-cooled radial airplane engine, the first of its type to pass the British Air Ministry's exacting tests, which include a 50-hour continuous run under full load.

The weight of the engine is slightly less than two pounds to the horsepower, and the fuel consumption is only six tenths of a pint to the horsepower hour.

The radial motor is not only light, but is shorter and more compact than the water-cooled type. Its circular shape adapts it to mounting in the front of the fuselage. In fact, a standard mounting is provided that can be fitted to the end bulkhead of any plane, in such a way that the engine can be removed easily for repairs.

Cylinders of the radial engine do not revolve, but the connecting rods of all nine cylinders are attached to one common crank, with the propeller acting as a flywheel. This design eliminates the inertia torque, simplifying gearing of the propeller. Air-cooling dispenses with radiator, piping, and water troubles, and strangely enough it is more efficient than water-cooling, both at high altitudes and in hot climates.



Four men can carry the new radial motor, which weighs less than two pounds to the horsepower. Insert shows how the engine is mounted in the hinged nose of the airplane to make it easily accessible

Molasses Detects Water in Gasoline Tank

MOLASSES, in little dabs on the end of a cheap pine stick, to detect water in gasoline, will save the auto owner many dollars a year, according to Wisconsin inspectors, who declare the test is infallible for these reasons:

Gasoline will not dissolve molasses, while water will. Any water in the fuel collects at the bottom of the tank. Thus if a stick coated with molasses is inserted into the tank, it will not be affected if the gasoline is pure; but if water is present, the molasses will be cleaned off the end of the stick.

A telltale length of bare wood reveals the exact amount of water hidden in the bottom of the tank.

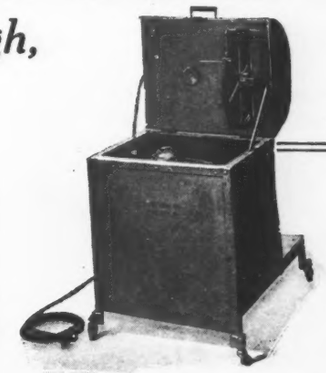
NAMES of prize winning Gipsy Motorists who submitted the best suggestions in POPULAR SCIENCE MONTHLY'S summer camping contest will be announced in the June Automobile Camping Number.

Electric Motor Drives New Maid-of-All-Work

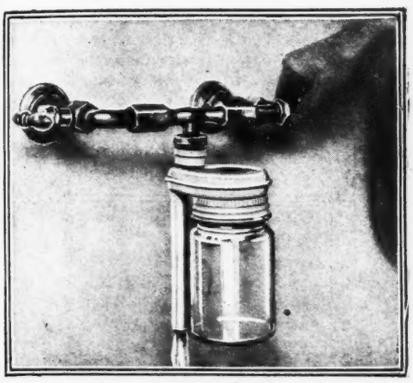
Versatile Machine Mixes Dough, Beats Eggs, Freezes Cream

This electric heater for kitchenette use is just large enough for two pots or pans

Here's a whole kitchen in one machine that will grind coffee, chop meat or vegetables, beat eggs, slice fruits, mix dough, batter, sauces, or dressings, strain soups, or freeze ice-cream. It is driven by a small electric motor and works at three speeds

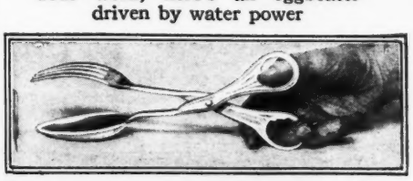


Closing the lid starts this electric ice-cream freezer



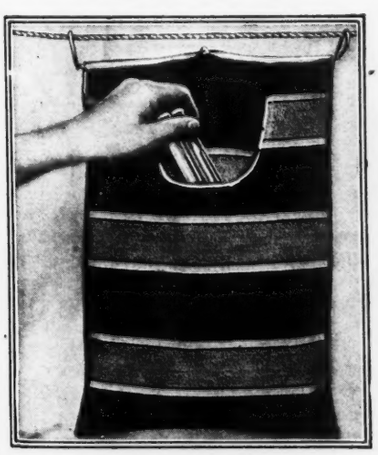
If beating eggs by hand is too strenuous work, here's an eggbeater driven by water power

An electric lamp behind an opalescent glass shade set in the top of this shaving mirror supplies a bright light for shaving, but does not dazzle the eyes of the shaver. It may be connected by a plug and cord with any light socket



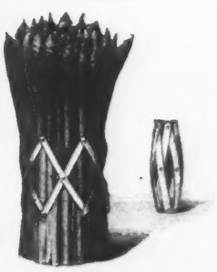
The two parts of this aluminum server may be used together like a tongs, or separately as a fork or spoon.

When you open a can with this tool, the cut edge of the lid will be smooth

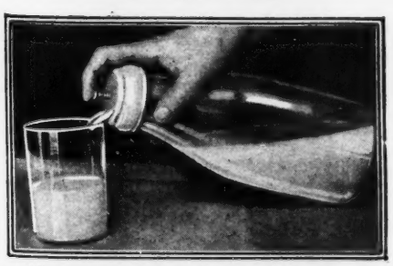


This washable clothespin bag can be moved along the line

The coilspring takes up the slack of the wire, preventing the dragging cord from touching the iron



To serve asparagus or macaroni in neat stacks, place them nicely bunched in one of these aluminum holders and leave the holder on while the food is cooking



You may pour milk from the bottle without spilling a drop by using this airtight elastic cover

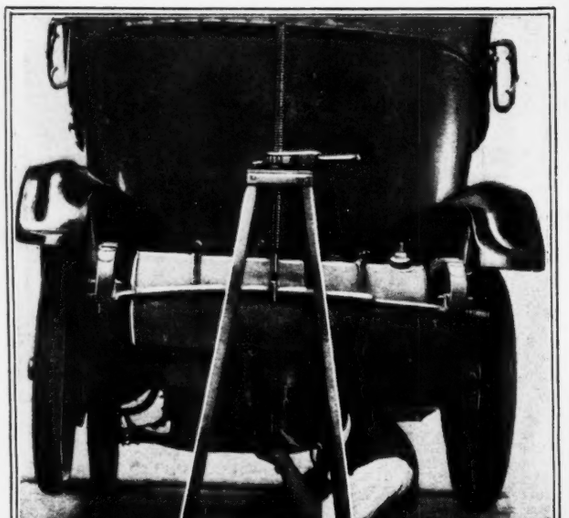
AS a special service to readers, the Editor will be glad to supply the names and addresses of manufacturers of devices mentioned in POPULAR SCIENCE MONTHLY.

If the conical pestle is given a stirring motion, it will quickly press vegetables through the meshes

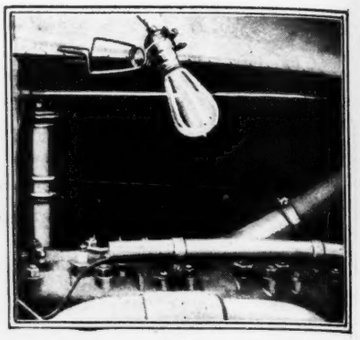
Crawl Under Safely! This Jack Holds Car Steady

New Motoring Aids to Help Put Your Car in Summer Trim

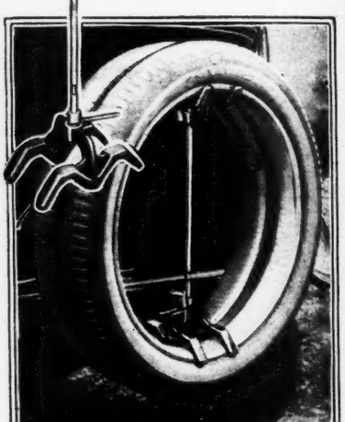
Cylinders may be rebored without removing the engine from the car with this hand-operated machine. Its feed is automatic



Place an iron bar beneath the springs, fasten to it the hook at the lower end of the long screw, which is threaded through the head-plate of this steel jack, and you may safely lift the car to a height of several feet. The braced legs of the jack are spread two feet at the bottom and cannot easily be upset. The turning of the lifting screw is made easier by a ratchet, which also serves to hold the screw in position after it has been set to the desired height

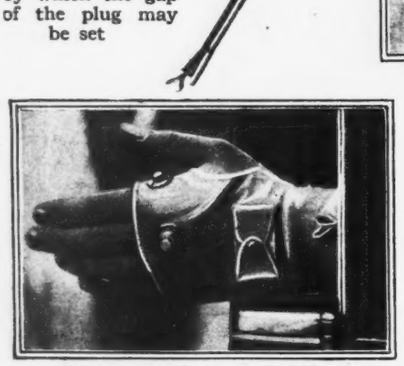


This spring-clip holder with rubber-protected jaws transforms any electric lamp into a trouble light by clamping it where it is needed



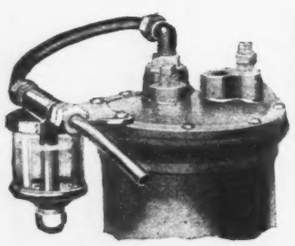
This extra tire carrier clamps the extra tire to the spare when the connecting bolt, specially threaded, is turned

The arrow points to the adjustable spark gap in the handle of this tool by which the gap of the plug may be set

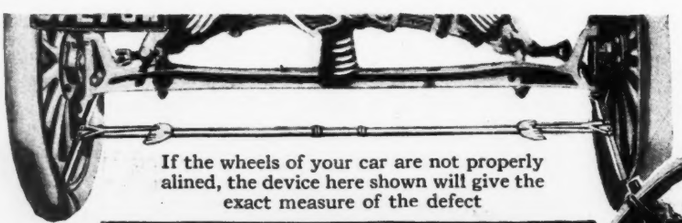


Press the button and the tiny glove lamp will flash

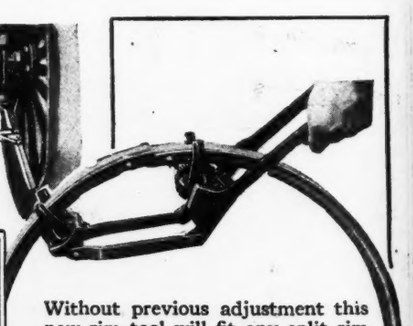
As a special service to readers, the Editor will be glad to supply the names and addresses of manufacturers of devices mentioned in Popular Science Monthly



There is satisfaction in seeing your gas pass through this strainer

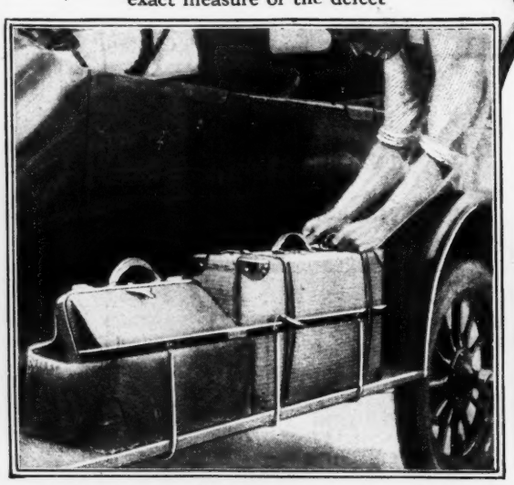


If the wheels of your car are not properly alined, the device here shown will give the exact measure of the defect

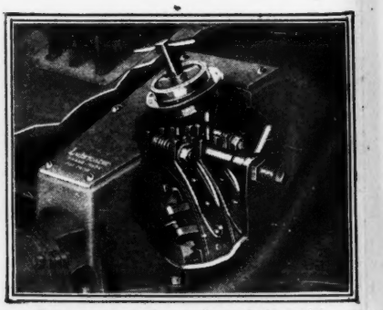


Without previous adjustment this new rim tool will fit any split rim and will quickly remove it

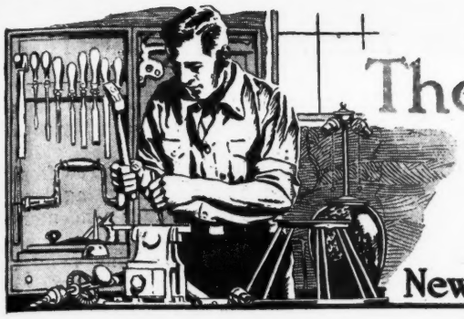
Much rattling of worn spring bolts may be avoided by using fabric shackles



The luggage carrier folds out of sight when not wanted and will hold two suitcases or traveling bags on the runningboard



Ford owners have found that this lubricator will prevent glazing of brake and transmission bands



The Home Workshop

New and Useful Things for the Practical Man to Make

A Motorcycle Drives This Homemade Catamaran

By P. P. Avery

ANY standard motorcycle will serve as the power plant for this novel catamaran or speed raft. The rear wheel of the motorcycle drives an 8-in. wooden roller by friction. This in turn drives either a small paddle-wheel or a propeller, whichever the builder prefers.

The boat is supported by two cylindrical pontoons 14 in. in diameter. They are merely kitchen boilers of either galvanized iron or copper. The nose for each is made of the same material shaped down to a point. The air chamber is continuous through each pontoon and the construction must, of course, be absolutely airtight. With the full load the displacement should be such that the waterline is halfway up on the cylinders.

The pontoons are attached to a wooden framework by ½ in. by 3 in. flatirons, as shown. Use ⅜-in. bolts with lockwashers top and bottom for fastening the laps around the tanks.

The flooring should be of sound tongue-and-groove stock well nailed on. Upon the strength and rigidity of the platform depends much of the working efficiency and safety of the completed catamaran. The floor is later covered with canvas, tacked on with copper or galvanized iron nails.

The openings in the floor are reenforced by 1 by 1 in. angle irons screwed fast all around.

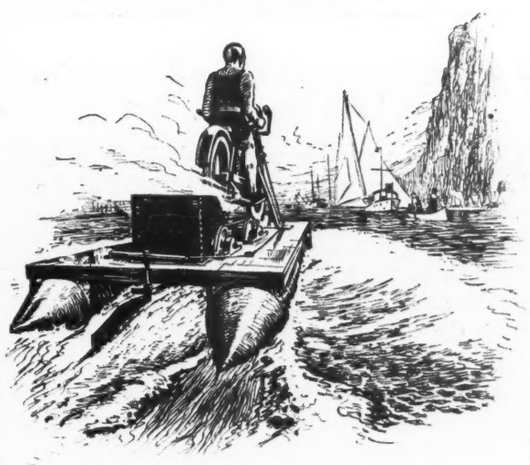
The heavy mountings such as those for the roller shafts should be secured with ⅜-in. bolts through bearing, angle iron, and floor, using large washers, lockwashers, and nuts.

The motorcycle should be stripped of parts that are not absolutely essential to its use as a power plant. The front wheel rests in a wooden block and the machine is firmly clamped in place, front and back.

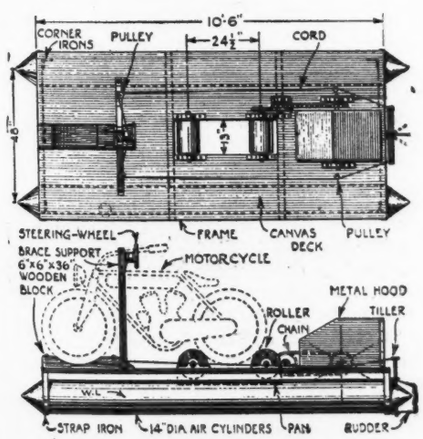
The rear wheel rests on the rollers, as shown, and the rear roller provides the driving power for either the paddle-wheel or propeller. Gears and a chain are used for driving the paddle-wheel and bevel gears and countershaft for the propeller.

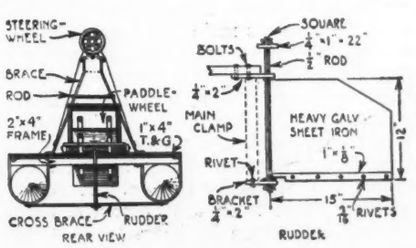
All exposed metal parts should be painted with iron paint and the woodwork given two coats of the best spar varnish. These details are all clearly shown in the accompanying drawings.

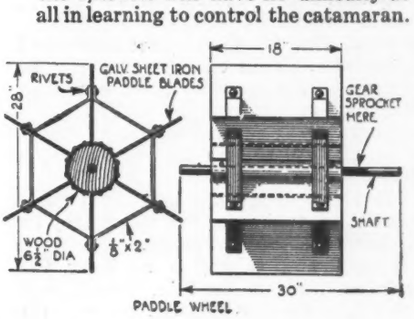
To operate the catamaran, the engine is started by the usual kick-pedal method, the clutch being in neutral. The speeds are advanced as desired and after the motor is in "high" gear, adjustment is by spark and gas on the handle-bars. The tiller wheel is conveniently located for steering so that the operator will have no difficulty at all in learning to control the catamaran.

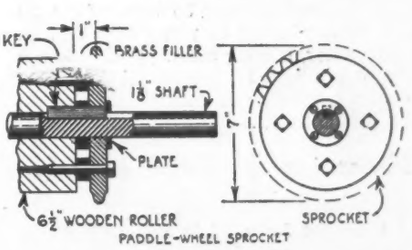


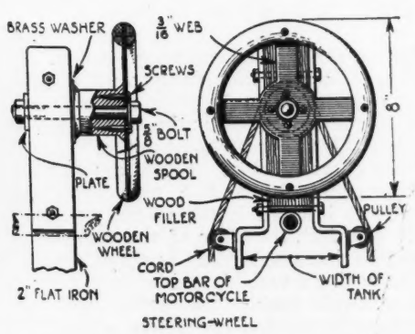
This unique power raft is driven by an ordinary motorcycle, the mechanism and controls of which do not have to be altered

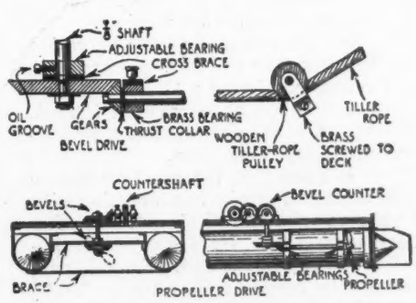


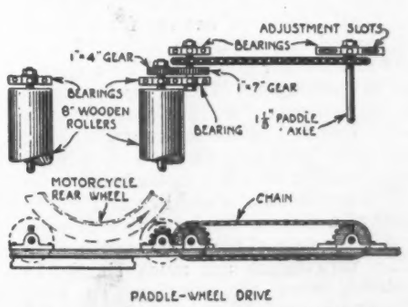












Complete assembly drawings of the catamaran and details of the steering-wheel, rudder, propeller drive, and paddle-wheel drive. Either propeller or paddle wheel may be used. The position of the motorcycle is indicated by the dotted lines in the side view

How to Make a Two-Stage Radio Receiving Set

By E. L. Bragdon

PROBABLY no one set has proved so successful in making the radio telephone live up to its prestige as the two-stage outfit. The audion detector is a big step beyond the crystal detector; the single stage of amplification somewhat steps-up the strength of signals, but the first big increase is noted when the second stage is added. The amplification made possible by the two amplifying tubes seems to make up for the deficiencies in most amateur aerials and grounds. Added to this is the remarkable selectivity possessed by the tuning circuits of these sets. In the set about to be described the best features of several types of outfits have been incorporated, and in one particular—that of ample space to work in—the set will receive the commendations of any amateur fortunate enough to build one.

The steps followed in construction should be as follows: winding of variocoupler and variometers; making of supports for vacuum tubes; machining of bearings and pivot rods for coils; planning and bench work on panel front. After finishing the panel unit, the set can be given an added value by enclosing it in a well made cabinet such as is described on the opposite page.

For the primary tubes for variocoupler and variometers secure a 15-in. length with a diameter of 4 in. These tubes can be of cardboard or fiber. Cut the 15-in. length into three equal sections. Take one of the tubes and, beginning at a point 2 in. from an end, wind on 80 turns of No. 20 double cotton-covered copper wire. Take off taps at every 10 turns up to the seventieth, and from then on take off taps at every turn. The single-turn taps will be connected with a "units" switch and the 10-turn taps with a multipleturn switch.

The rotors or secondaries can be made from 3½-in. tubing, or ball rotors may be purchased ready for windings.

If cardboard tubing is used for the secondaries, secure an 8-in. length, and divide into three sections as before. On one of the sections wind 30 turns of No. 20 d.c.c. wire, winding 15 turns on each side of the center, leaving a full ¼ in. between the two windings for the swivel rod. The secondary winding is continuous and no taps are taken off.

Variometers Are Simple to Make

A piece of ⅛-in. brass rod, 6 in. long and threaded for a ½ in. on one end will be needed for each of the three tuning coils. The panel forms one bearing for this rod and the primary tube the other. Movement of the rotor is obtained by a simple wire key passing out of the tube through a hole in the brass rod and back into the tube again. One end of the secondary winding may be soldered fast to the rod, using a piece of flexible wire or a motor brush "pigtail." The other end should be carried, by means of a piece of insulated flexible wire, through the base of the primary tube.

The variometers are much simpler to construct, since the windings on both primary and secondary are continuous and there are no taps on either. The variometer windings differ from the variocoupler in the fact that the swivel rod passes between the windings on primary as well as secondary. Space should be allowed for this purpose.

On one of the 4-in. tubes, commencing at a point 2 in. from one end, wind 10 turns of No. 20 d.c.c.; anchor securely; cross the space allotted to the pivot rod, and continue with 10 turns on the other side. Wind both variometers alike.

Use either the 3½-in. tubes for the secondaries or the ball-shaped rotors. Whichever is used, wind 15 turns on each side of the pivot rod. Connect each primary with its corresponding secondary by a "pigtail." As previously done with the variocoupler, connect the spare end of the rotor to the rod that has been inserted in primary and secondary.

Best results with an amplifying set, inductively tuned as this one is, are obtainable if the two variometers are separated some distance. This can be easily accomplished by locating the variocoupler between them. The "units" and "tens" taps are led to the switches, and care should be taken that they are attached in proper order. Although it makes no great difference, the standard practice is to arrange the tuning switches so that turns are added (wave length increased) by rotating handles in a clockwise direction.

When completed, the variocoupler and variometers are mounted in place on the baseboard. By inserting a ⅛-in. piece, cut to circular shape to fit the bottom of the tubes and held there by brass tacks, the tubes themselves may be secured to the base by screws inserted from below.

Dials are not essential to the operation of any set, but they will be found handy in case the amateur keeps a "log book" and they do add to the appearance of the set. Combination knobs and dials can be purchased from any radio store.

There is little that the amateur can or should attempt to make in connection with the vacuum-tube end of his set. The few dollars more spent for factory-built apparatus will pay in the end. For this part there will be needed a detector or "soft" tube and two amplifying or "hard" tubes. The two last-named tubes will require amplifying transformers and each of the tubes will need a grid condenser, preferably with grid leak.

By placing the three tubes in a row from front to back of the set and mounting them high to leave space beneath for condensers and transformers, the set is compressed without decreasing its receiving ability. The uprights for the tube platform are made of strip brass 1 in. wide, bent in the shape of a U, 5 in. on the side and 4⅛ in. on the top. The open ends of the U are bent inward 1½ in. to take a hole for the 3/16 in. brass bolts to the base. As a certain amount of spring is not undesirable, two of these supports will be sufficient. It is a good plan to insert small pieces of sponge rubber beneath the platform supports, if possible, to take up any vibrations from the outside.

Between the two supports lay a piece of well paraffined wood or bakelite, ½ in. thick and 4 in. wide. Brass machine screws hold this strip to the supports and the vacuum-tube sockets may be screwed down directly on it. The amplifying transformer for each tube is fastened to the under side, permitting the shortest possible leads between tubes and transformers. The grid condensers can be placed where they come most handily in the grid circuits.

The detector tube will require one rheostat and the two amplifiers another. These rheostats can be wound at home, but inasmuch as their design plays such an important part in the close regulation of the filament current and the consequent life of the tubes, the amateur should buy them if possible. There are good types on the market in which the coils are embedded in the material composing the knob and dial. They are neat and easily attached. Other types are fastened to the back of the panel with a control rod passing through to the front.

Place Panel in Cabinet

For the sake of neatness, connections should be carried through the back or side, thus leaving the front for telephone and loud-speaker connections and instrument dials. Although the aerial and ground connections are frequently found on the front, they would give as good results hidden in the rear. If the set is placed in a cabinet, these little improvements can easily be carried out by making the back of the cabinet permanent and placing on it the binding posts for all external connections.

Either binding posts or jacks can be provided for telephone connections to the detector, first and second stage circuits.

Since this is an inductively coupled set, no air condenser has been arranged for. In the event that the natural wave length of the aerial is too great to admit of tuning to the short amateur waves, a variable condenser of about .001 mfd. capacity should be inserted in the ground connection. In fact, the range of the entire set could be increased many hundred meters by arranging a variable condenser through a double-pole double-throw switch, so that the capacitance can be thrown either in series with the primary tuner or in shunt around it.

A Blueprint Will Help You Make a $125 Set for $40

THE article on this page is designed to be used with or without the blueprint of the receiving set prepared by the Home Workshop Service Department (see page 84), although to make his work as simple and certain as possible, the novice is advised to obtain the scale drawings.

In either case it should be kept in mind that the Information Department will answer any questions and make suggestions regarding the construction, assembly, and operation of the outfit.—*Home Workshop Editor.*

This Neat Radio Cabinet Is Easily Constructed

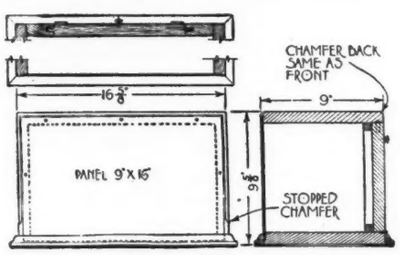
By James S. Godfrey

MANY efficient, up-to-date receiving sets have an amateurish appearance because the builder has been so intensely interested in the hook-up of his instruments that he has neglected to construct a well-designed and good-looking cabinet to contain them. It is just as easy to build a neat and substantial case as a crude and flimsy one.

The cabinet illustrated was designed especially for the radio enthusiast who wishes to assemble his own receiving set or has purchased commercial panels that have no case. The advantages of this case are its simplicity of construction, its solidity, its neat appearance, and, finally, the accessibility of the instruments.

When any remodeling of the set is necessary, or if soldering has to be done, the door is opened and, after the removal of a few screws, the entire top is lifted off, so that every corner of the interior is within reach.

The cabinet is made of whitewood, stained and finished to represent mahogany. Other woods, of course, can be used—pine, cypress, gumwood, chestnut, oak, mahogany, and many more. The stock is ⅛ in. throughout; ½ in. could be used, but



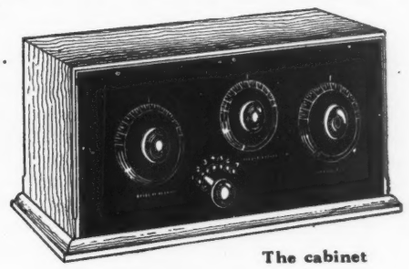
The front of the case and sectional views of the top and end

the thicker wood was selected so that the case would be as rigid and free from vibration as possible.

The panel in this instance is 9 by 16 in. If it is desired to use a smaller or larger panel, the dimensions of the case may easily be changed to suit, without altering the design or method of construction.

The panel fits flush into a rabbet, as shown in the lower detail marked "Section through Bottom of Case." This rabbet is made alike in the two ends, the top, and the bottom. The panel is secured by screws in the top and ends, as shown, and is held at the bottom by the front molding.

The ends fit into rabbets in the top and bottom, as shown in the detail marked "Section through End." It will be noted that in each case the thickness of the wood left after the rabbet has been cut out is 5/16 in. The bottom, of necessity, has a 3/16-in. rabbet, 9/16 in. deep along its front edge, to take the bottom of the panel and a ⅞-in. rabbet 9/16 in. deep along its short edges to take the ends. The back edge where the door is hinged is the only



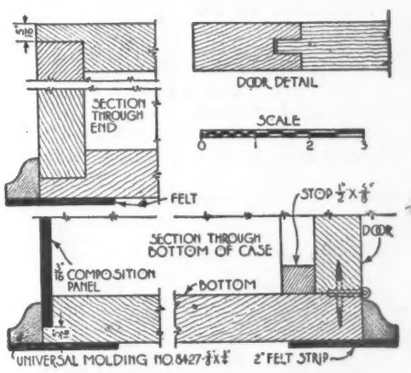
The cabinet

edge of the bottom that is not rabbetted. The top is rabbetted exactly the same as the bottom. Top and bottom are pairs and the ends are pairs.

The door has two end strips or battens, as shown in the door detail. Instead of the tongue and groove joint indicated, a slip-tongue joint or a dowelled joint may be used, as the maker prefers. A door stop ½ by ⅝ in. is placed all the way around the inside of the door. A single strip across the top may be substituted.

To improve the appearance of the case and to conceal the joints as much as possible, a molding is mitered around the bottom. That shown is a standard molding, No. 8427. Any similar small molding or even a quarter-round could be used in its place. A ¼-in. chamfer is run around the front and back, as shown; it will be necessary to stop this chamfer 2 or 3 in. above the bottom of the case. Strips of felt 2 in. wide are glued to the bottom along all four edges, or, if a large enough piece is available, it can be glued over the entire bottom.

After the case has been completed and thoroughly and carefully sandpapered to a perfectly smooth surface, it may be stained, if it is made of whitewood as suggested, with a good quality of dark mahogany varnish stain intended for use on a light wood such as whitewood. Be careful that there are no sandpaper marks across the grain or any scratches in the wood, for no matter how slight they may seem to be on the unfinished wood, they will immediately become conspicuous when the stain is applied.



Details that show the exact construction

A more enduring and finer finish can be given by first staining the wood with a dark mahogany stain and shellacking it with several coats of thin shellac, rubbing the shellac down very lightly with fine sandpaper after each coat. Finish with two or more coats of good quality varnish. Still another way of finishing is to stain the case, shellac it, and then apply coats of wax; this finish is easily freshened up with a little wax when it becomes dull or finger-marked.

The bill of materials for the cabinet is as follows:

1 Panel 3/16 by 9 by 16 in. composition, fiber, or hard rubber
1 Piece for bottom ⅜ by 9 by 16⅝ in. whitewood
1 Piece for top ⅜ by 9 by 16⅝ in. whitewood
2 Pieces for ends ⅜ by 9 by 9 in. whitewood
1 Piece for door panel ⅜ by 7⅛ by 11⅛ in. whitewood
2 Pieces for door battens ⅜ by 2 by 7⅛ in. whitewood
1 Piece for door stop ½ by ⅝ in. by 4 ft. whitewood
1 Piece molding Universal No. 8427, ⅝ by ¾ in. by 5 ft. whitewood or pine
1 Pair wrought brass narrow fast joint butts 1½ in. with screws
1 Spring ball catch
1 Brass or glass knob for door
1 Piece felt for bottom

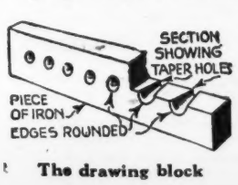
The actual sizes are given in the above list; allow extra for cutting. A few brass screws and brads and glue will also be required.

The high gloss on most composition panels, which is usually regarded as undesirable by radio men, may be removed by rubbing the composition down well with rottenstone and linseed oil.

How to Make Small Brass and Copper Tubing

IT is not difficult to make brass or copper tubing of any desired size. All that is necessary is a drawing block and wire of the right size for mandrels.

A good drawing block can be made from a piece of iron 8 in. long, 2 in. wide, and ¾ in. thick. Drill about seven holes of varying sizes, the smallest ⅛ in. in diameter. These holes must be reamed to a taper, and the larger edges nicely rounded off.



The drawing block

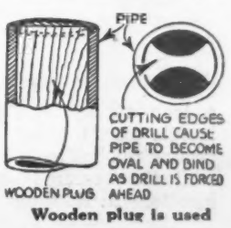
This block is placed in the vise with the wide ends of the holes facing away from the operator. A piece of brass or copper of sufficient width to make the tube is cut and started around the mandrel with pliers or a hammer. This is then placed in one of the larger holes and drawn through, and again drawn through a smaller one, and so on until the joint is tight. The mandrel is easily withdrawn and the joint silver soldered. A little practice will make the process seem simple.—D. E. CRABB.

THE filament of an electric lamp remains hot long enough after the globe has been broken to ignite a dust cloud, according to United States government experiments. Dust collected in layers on the top of gas-filled globes will take fire if allowed to remain long enough.

To Prevent Drill Binding in Pipe

IN drilling out brass, steel, or wrought-iron pipe, it frequently happens that the drill binds. This is caused by the edge expanding the pipe and wedging forward until either the drill twists off or the pipe starts turning in the clamp.

An expedient to overcome this difficulty is to drive a wooden plug solidly into the pipe and drill jointly into the wood and metal. The core prevents the cutting edges from distorting the pipe.—G.A.T.



Wooden plug is used

Adapting Your Phonograph to Receive Radio Concerts

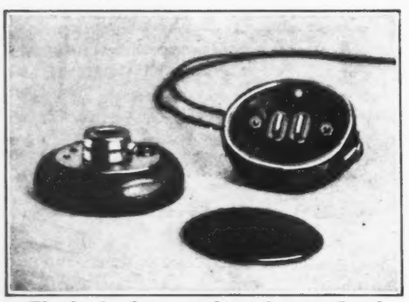
IT is not difficult to adapt your phonograph as a loud talker without interfering with its ordinary use.

The method used by one radio expert in New Orleans is as shown in the accompanying photographs. The back of an ordinary phonograph reproducer is cut out, leaving a plate to which a telephone receiver can be secured. Two holes are drilled through this plate and also through the cap of the telephone receiver. Then the two are fastened together with two machine screws and nuts, as shown clearly at the left of the smaller photograph.

A telephone receiver is attached to the tone arm

This adapts the telephone receiver so that it can be substituted directly for the ordinary reproducer and attached to the tone arm in the usual way. Wires are run as most convenient to the wireless panel.

A new phonograph reproducer will, of course, have to be purchased to take the

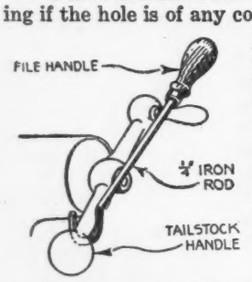


The back of a reproducer is cut off and screwed to the telephone

place of the one that was cut in two to form the connecting length between the telephone receiver and the tone arm.—EDWARD T. JONES.

Extension for Tailstock Handle Facilitates Drilling on Lathe

DRILLING a moderate sized hole with a drill in a lathe becomes quite fatiguing if the hole is of any considerable depth. This is due to the fact that the handle on the tailstock affords little leverage. An extension handle, as shown in the sketch, will be found useful for this work.



Leverage prevents fatigue

This handle is merely a ¼-in. rod, formed into a loop at one end and carrying a file handle on the other. The loop is passed around the ball end of the tailstock handle, while the pressure is exerted against the file handle.—R. H. KASPER.

Bench Talks

Forestalling Depreciation and Deterioration in Your House and Its Furnishings

By Arthur Wakeling

ARE you alive to the menace of Old Man Depreciation, that sly and wily foe, who is always waiting around patiently to place somewhere or other the stamp, "secondhand"? Few of us are apt to take sufficiently into account the losses we suffer through his assaults upon our property.

But perhaps we think about them nowadays more than heretofore, because the automobile is rapidly educating us to the fact that a very large and definite proportion of first cost is eaten up each year in depreciation. Every man who owns a car accordingly takes the utmost care to forestall and prevent all the wear and tear he can.

What is so obviously the case with automobiles is equally true of houses and furniture.

If you buy a house, the first thing you know the plaster has cracked here and there; this door and that door sticks or sags; the driving rains reveal an unsuspected leak around a window or elsewhere; faucets begin to loosen up and drip; the heating system starts to display those idiosyncracies that give every heating plant a character all its own. As the years pass the defects multiply, unless they are constantly remedied as they arise. The outside of the house, even if it is of brick, shows the effect of the heavy frosts and storms of winter. A shingle will come loose here and there, a piece of siding rot away underneath, the porch floor and pillars will go, the stucco and concrete will crack or peel or chip. If there has been any neglect worth speaking of, the average house will be distinctly an old house in ten years.

Age Should Mellow a House

This need not be. At ten years a house should be just becoming nicely "oiled," as it were. It should be not only in as good condition as when it was first built, but it should be improved in the thousand and one little ways. It should have acquired the grace and harmony that come from the toning of building materials by time and atmosphere. The woodwork should have the rich and well-cared-for bloom that nothing but time and loving attention will give. The whole house should have gained in its first ten years the beauty and character that are to distinguish it and make it truly a "home."

There are many ways in which you may obtain these results. The first essential is that you take a keen, enthusiastic and unflagging interest in your house and its furnishings. Study carefully every detail with a view not only of keeping it in repair as easily and economically as possible, but also of improving it. This is not as simple as it sounds, for while we are all interested, necessarily, in the places in which we live, we become so accustomed to them that we are usually as blind to their defects as to their hidden possibilities.

The next essential is to make all repairs as soon as they are necessary. It is a futile waste of money to wait; a delayed repair invariably costs more than an immediate one.

Saving the Surface You Save All

The third important point is to forestall repairs as far as possible by preventive measures. Be prompt and liberal in the use of paint, oil, wax, shellac, and varnish. There is much truth in the statement that if you save the surface you save all. Woodwork that goes unpainted long is bound to rot; floors that are not properly waxed, oiled or varnished, wear and become ingrained with dirt; metalwork that is not painted, particularly gutters and drainpipes, will rust; furniture that is not constantly watched will almost certainly come to grief.

To keep alert to these things you need only to read POPULAR SCIENCE MONTHLY, which publishes each month a large number of useful suggestions written especially to help you in repairing and improving your home and its furnishings. You will find these practical ideas not only in the "Keeping the Home Shipshape" department, which is devoted solely to them, but also scattered through the magazine.

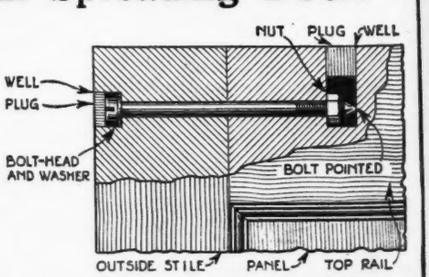
After you have become skilful at putting in new sashcord, easing doors, fitting keys, and the many small things that have constantly to be attended to around the house, you will understand the advisability of calling in a competent mechanic to do the more difficult repairs.

No man who is genuinely and intelligently interested in this subject of maintaining and improving his home ever lacks enjoyable occupation for his leisure hours. He has one of the soundest and most satisfactory of all hobbies.

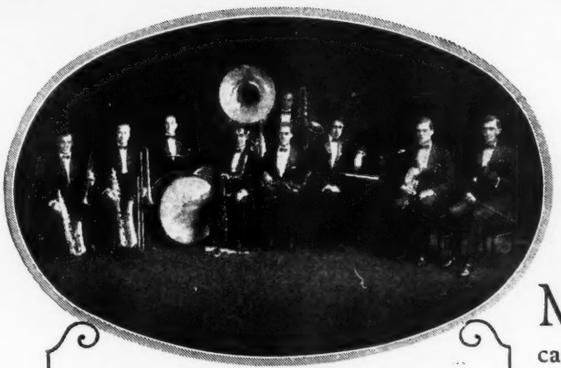
Using Bolts to Rejoin Spreading Doors

THE stiles and rails of doors sometimes draw apart, especially at the top. To remedy this condition, a repair can often be made such as that shown in the accompanying illustration.

The bolt should be of small diameter and several inches more in length than the width of the stiles. It may be turned down with a socket wrench or even slim nose pliers, or a screwdriver may be used if the head is slotted. The nut and bolt will engage more readily if the threaded end of the bolt is filed to a point.—L. S.



The bolt binds rail and stile together



Chicago Program by Benson's Orchestra, of Victor record fame, saxophone solos by M. Amaturo, Benson's Saxophone quartet, M Amaturo, R. Adkins, E. Cary, J. McClure; and vocal numbers by Irving Berlin Trio.

New York Program by Joseph Smith's famous orchestra, (Smith photo above) Saxophone solos, H. Benne Henton (center) Trombone solos, Charle Randall, (below). Vocal numbers by Irving Berlin Trio.

Denver Program Cornet solos and duets by John Leick (above) and Mabel Keith Leick (below) numbers by Hal J Nichols Jazz Orchestra; Saxophone solos, Guy Hopkins; Tenor solos, Horace P. Wells.

San Francisco Program Popular numbers by Rosebrook's band, Cornet solos by D. C. Rosebrook (above), Trombone solos by Fred Tait; Soprano solo Miss Helen O'Neill.

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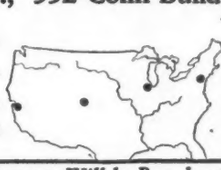


Northwest Conn Co., 708 3rd Ave., Seattle, Wash.
Southern Conn Co., 317 Baronne St., New Orleans, La.
McDougal Conn Co., 129 10th St., Portland, Ore.

Conn Concerts Will be Broadcasted From:

CHICAGO	NEW YORK	DENVER	SAN FRANCISCO
Westinghouse Radiophone Broadcasting Station KYW Morgan L. Eastman, sending director. Wave length 360 meters. Concert 8:00 to 9:00 P. M. Central Time.	Westinghouse Radiophone Broadcasting Station WJZ at Newark, N. J. W. H. Easton, wireless director. Wave length 360 meters. Concert 8:00 to 9:00 P. M. Eastern Time.	Reynolds Radiophone Broadcasting Station ZAF Mr. William Reynolds, sending director. Wave length 360 meters. Concert 8:00 to 9:00 P. M. Mountain Time.	Fairmont Hotel Radiophone Broadcasting Station KDN Mr. S. Peterson, operator. Wave length 360 meters. Concert 8:15 to 9:15 P. M. Pacific Coast Time.

CONN

WORLD'S LARGEST MANUFACTURERS OF HIGH GRADE BAND AND ORCHESTRA INSTRUMENTS

The most progressive family has a MAGNAVOX Radio

Everyone will envy you these evenings of pleasure

TO enjoy the thrills of a Magnavox Radio is a matter of *progressiveness* rather than *wealth.*

The average family, when alive to its possibilities, can and *will* secure the simple, dependable equipment which gives the home circle the inexhaustible resources of *wireless entertainment.*

Radio brings it MAGNAVOX tells it

ATTACHED to any commercial receiving set, the Magnavox Radio reproduces every sound in full volume, transforming wireless telephony from a scientific "fad" into a universal *home service.*

The Magnavox Radio makes it possible for you to hear all that is in the air as if it were being played by your phonograph.

Any radio dealer will demonstrate for you, or write to us for descriptive booklet and name of nearest dealer.

The Magnavox Co.
Oakland, California
N. Y. Office: 370 Seventh Avenue
Penn Terminal Building

Answers to Puzzles

(*Concluded from page 66*)

length. Multiplying gives us 92,160,000 inches as the length of wire that can be spun from the sphere.

Reduced—1454 miles 2880 feet.

BROWNS AND JONESES

Let X equal the number of minutes it took Jones to reach Brown's home, and Y equal the number of minutes it took Brown to reach Jones' house.

Then $\frac{3X}{2}$ equals 15 minutes plus $\frac{Y}{2}$, and $\frac{3Y}{2}$ equals 11 minutes plus $\frac{X}{2}$.

X equals 14 and Y equals 12.

Since they met at four o'clock, and the Joneses took $1\frac{1}{2}$ X minutes to go to Brown's and back to meeting place, they must have left home at 3:39.

The Browns having traveled for 18 minutes must have left home at 3:42.

VOTING A BUS ROUTE

It is apparent that in traveling from U to C by an 8-block route, the progress must never be other than south or east.

Calling the streets running horizontally, from north to south, 1, 2, 3, 4, and 5; and the streets running vertically, from west to east, A, B, C, D, and E, let us start eastward on First Street, and make the first turn down E Street, which is straight to the station.

Starting again, we proceed eastward to D Street, through which street we are offered a choice of four different routes to the station.

In the next start eastward we turn down C Street, which provides 10 different routes of shortest length.

Turning down B Street in the next eastward start, we encounter 20 routes, all different in some respect and of the same length.

Thus, 35 different routes develop from an eastward start, and since a start southward presents like possibilities, we have a sum total of 70 different routes that might have figured in the balloting.

February Answers

THE SPEED OF THE TRAINS

In passing the slower train the faster train gains on the slower a distance equal to the total length of the two trains—2200 feet—in 150 seconds.

At that established rate, when the trains pass in opposite directions, in 30 seconds, they have together covered 2200 feet, and the faster must have gone 30/150 of 2200 feet farther than the other. Thus, the faster train went 1320 feet, and the slower train 880 feet, in 30 seconds, which figures 30 miles an hour for the limited and 20 miles an hour for the local.

PAYING THE SMITH

The old chain could be cut and welded to produce the required six pieces, at a total cost of $6.40, thus saving $1.10 over a new chain investment.

The smith, assuming that he proceeded most expeditiously, first cut the sixth, thirteenth, twenty-first, and thirtieth links of the 39-link chain, producing complete pieces of five, six, seven, eight, and nine links respectively. The four open links were then joined into a 4-link piece by four weldings.

THE PLUMBER'S BILL

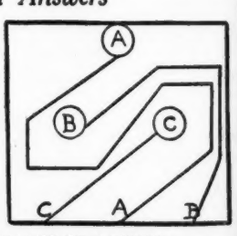
A tank in the form of a cube would have the maximum capacity for outlay of copper, conforming to specifications, except that no top was required.

The most economical form of the topless tank is that whose bottom will be in the same ratio to the four sides as the top and bottom areas combined are to the four sides of a completely closed cube. One half of a perfect cube containing 1728 cubic feet has the dimensions of the desired tank. The tank, holding 864 cubic feet, therefore, should be 12 feet long, 12 feet wide, and 6 feet deep. It would take 432 square feet of copper to line it, which at 75 cents a square foot, makes the cost of the job $324.

March Answers

PRACTICAL WIRING

The diagram shows how the wires may be strung in conformity with conditions, no wires crossing.



BOYS DIVIDE THEIR LUNCH

Expressing the boys' cake, pies, and sandwiches in terms of cake, we find that Harry contributed the value of eight cakes, and Tom the value of seven cakes. Then John established the market value of the total refreshments by paying 15 cents for a one third interest. Therefore, Harry must be credited with a 24-cent investment, and Tom with 21 cents.

As each boy consumed 15 cents' worth, Harry was entitled to a rebate of nine cents and Tom to one of six cents. John's 15 cents was thus equitably divided by Harry taking nine cents and Tom six cents.

CHECKING THE GRINDSTONE

The diameter of the shaft hole is one fifth the diameter of the stone—15 5/7 inches. Squaring the diameters, the area of the stone is 25 times the area of the hole. Thus the stone area is 24 parts and the hole one part. Since the 24 parts represent one half of the original area, or bulk, of stone, then originally the stone consisted of 48 parts stone and one part hole, or a total of 49 parts. Taking the square root gives us seven to one as the ratio of diameters between stone and hole. Therefore seven times the given diameter of the hole, 3 1/7 inches, gives us 22 inches for the original diameter of the grindstone.

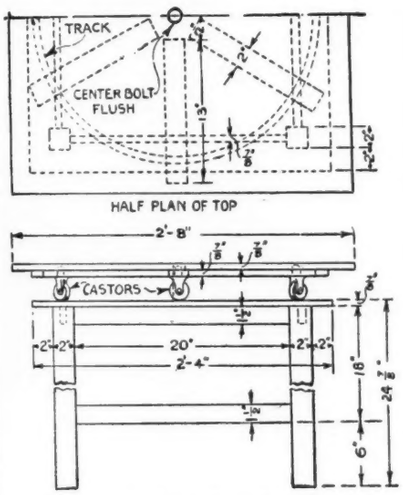
Revolving Table for Assembling, Sanding, and Finishing

THE revolving table illustrated in the accompanying drawings will not only be found useful for staining purposes, but also for sanding, filling, painting, and assembling furniture, or it may be used in the shop for cleaning and tearing down small machinery.

Varnishing a chair

The construction may be either mortised and tenoned or doweled. The revolving top is rolled on casters, either of the neck-grip or plate pattern. The pivot bolt in the center of this top is governed in length by the height of the casters used.

It may be advisable in some cases to attach a small shelf to one of the legs for

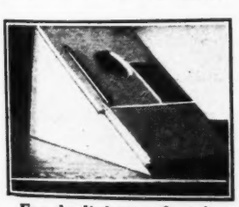


Working drawing shows simple construction of the table

holding cans of paint, stain, or the like. Tables such as this will be found a paying investment for woodworking. They will also be found very useful in school shopwork.—FRANK P. WENTZEL.

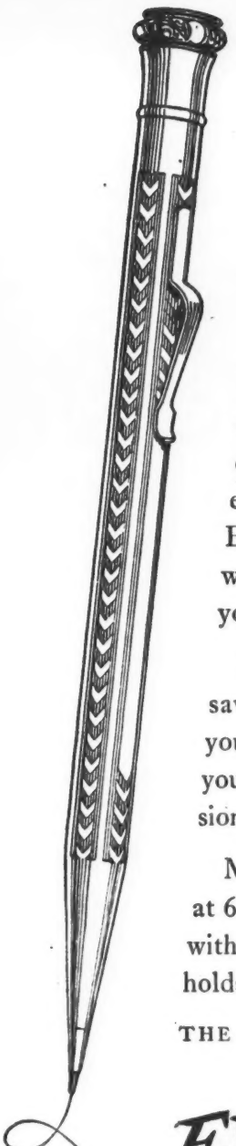
How to Make a Photo Negative Retouching Stand

THIS photo retouching stand was made by sawing a box in half diagonally. A piece of wood was nailed on top and a hole 4 in. wide was cut out to permit the light to shine through from inside. Heavy cardboard at the bottom holds the negative in place while it is being retouched.



For daylight or electric light

To illumine the negative, place the stand with its back near a window so that the light will shine into it or insert an electric socket and bulb under the stand, below the round opening shown in the photograph.—LOUIS GIANCOLA.



The Pencil of business efficiency

Clear thinkers write it down. They reach instinctively for their Eversharp, as they would for their watch. At the conference table, in the drafting room, everywhere in the day's work you find Eversharp making its mark smoothly, yet with firmness and exactness that reminds you no other pencil can be like Eversharp.

Efficiency did it! Eversharp is a time-saver; no sharpening, no interruption to your thoughts. Examine Eversharp and you wonder how such mechanical precision can be obtained in such small space.

Many styles in gold, silver and enamel, at 65c to $65. Matched by the Wahl Pen with the famous all-metal barrel that holds more ink. Sold everywhere.

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Use only Eversharp Leads, 12 in a box. They fit accurately. Seven grades.
2B—Extra Soft
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F—Firm
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Also Indelible

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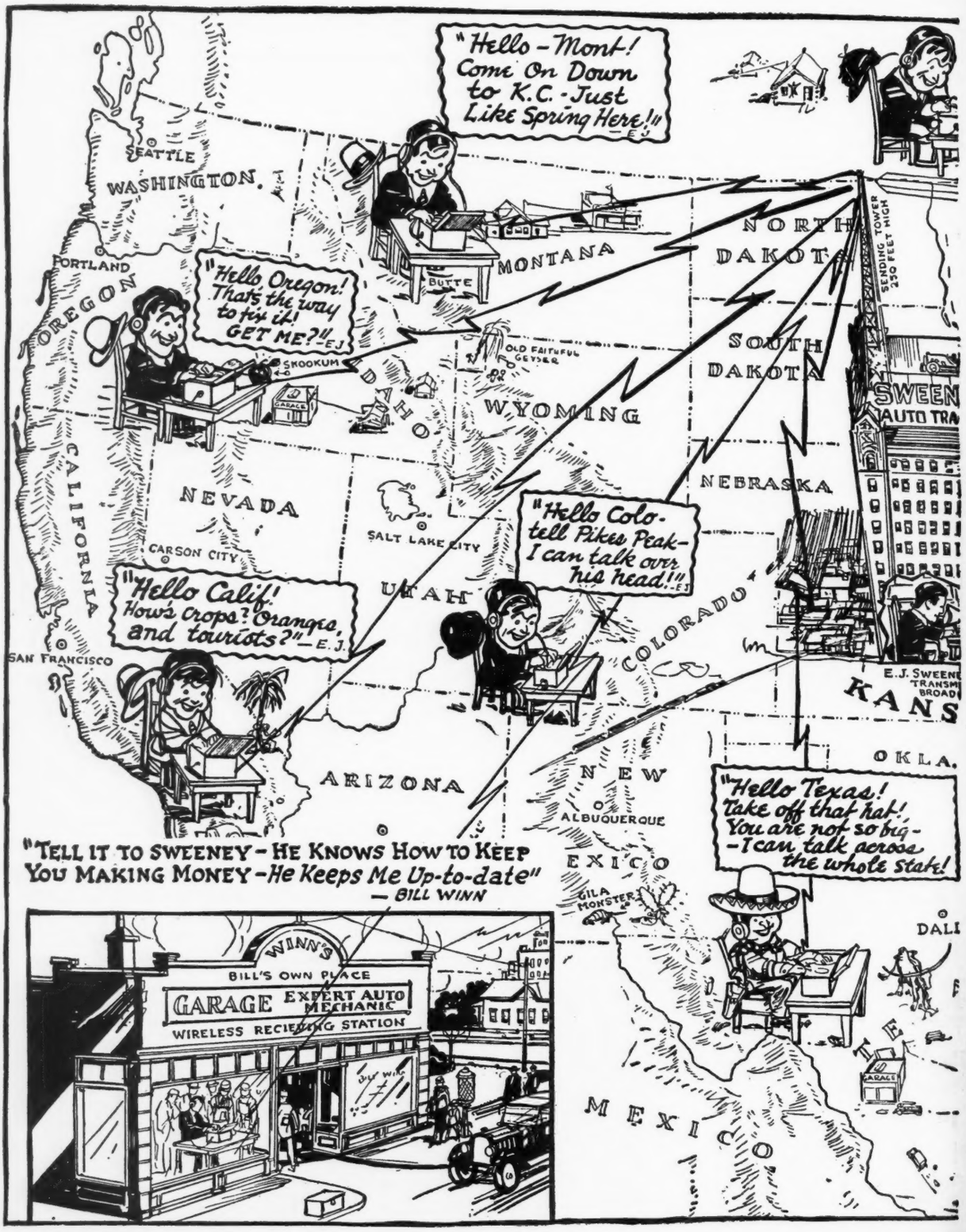

Come to the Sweeney Auto School and learn Radio work without a cent's extra charge. Receive messages—learn to build and install Radio sets—get agencies and sell sets—receive messages from all over the world—all this is now part of the regular eight weeks' course without advance in tuition.

The World is Radio Mad "Voices in the air" are the most amazing development of the century. Who is the right man to sell and install these simple receiving sets? The garage man or auto mechanic. These sets are cheap and easily made. Learn how to make them.

The Sweeney School is always the leader. That is why I am offering this great new development free.

Famous Experts Teach You Radio S. E. Adair, formerly Chief Engineer of the International Radio Company is in charge of Radio work and Superintendent of Electrical Instruction for the Sweeney School. His assistant, John Schilling, was formerly in charge of the Government School at New London and is an expert commercial operator. These men are practical men and no better can be found as radio instructors.

LEARN A TRADE
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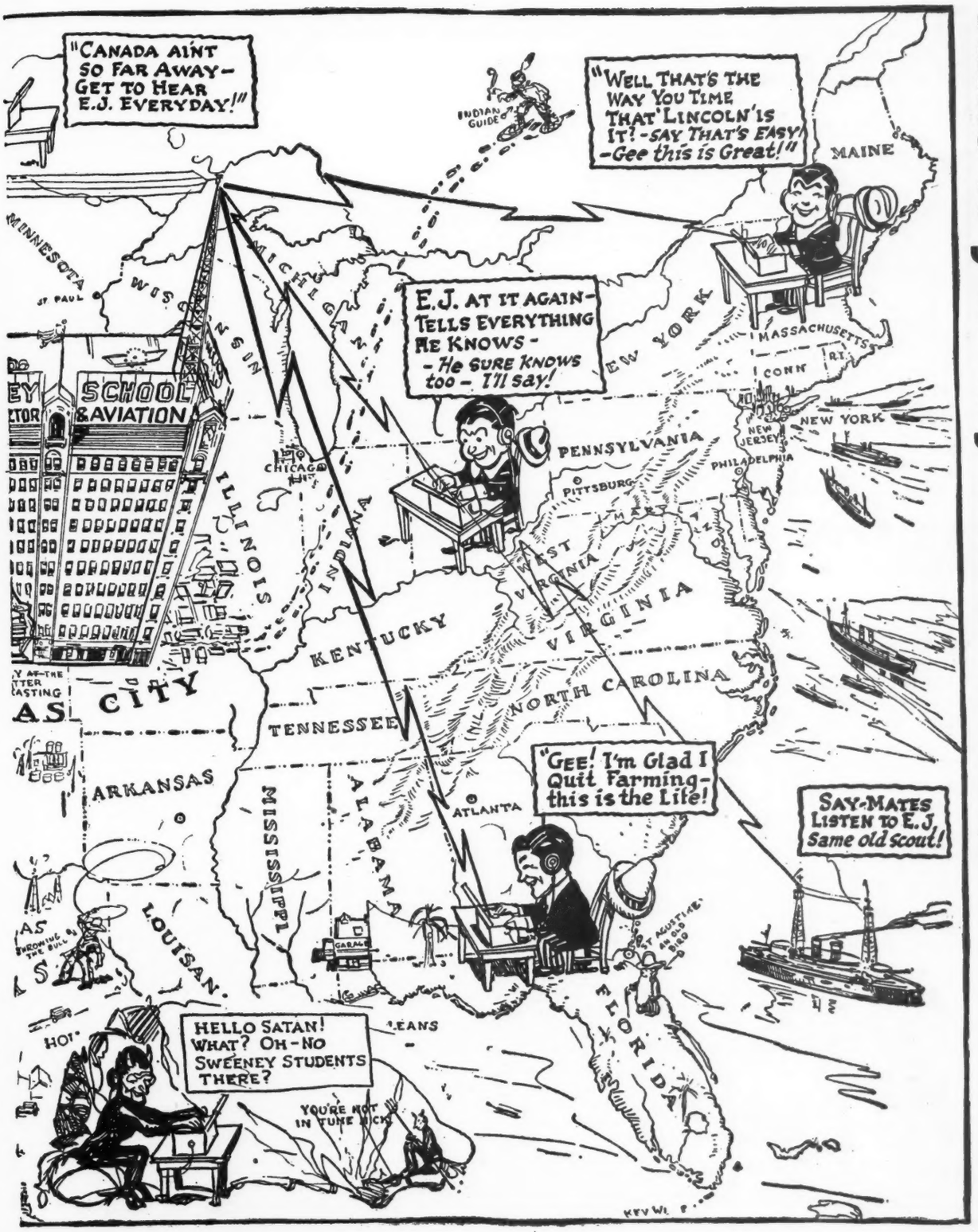
AT SWEENEY SCHOOL

Talks to you anywhere in the United States



I am not offering a course to make commercial operators but with one of the greatest sending stations right here in the Sweeney building, with free instruction and practical experience in receiving messages and assembling sets, with famous experts in charge, a thousand new opportunities are open to you.

Sit here in the receiving room and hear New York and San Francisco talk, hear concerts, news, the mysterious voices in the air. Learn to make a set of your own.

FREE The first step is to send right now for my big 72-page catalog. Tells how men just like you prepared themselves for and got big paying mechanical jobs. Takes you thru the Million Dollar Trade School. Hundreds of photographs. Facts about your opportunity in the automotive business. Sweeney News tells all about the new Radio work and the free course. Simply send name today.

E. J. SWEENEY, *President.*

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Please send me free without any obligation on my part, your 72-page catalog and your Sweeney School News. Tell me of the opportunities in the Auto and Tractor Business.

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FREE-This Book on Home Beautifying

S. C. JOHNSON & SON,
"The Wood Finishing Authorities"
RACINE, WIS. U.S.A.

THIS book tells how to finish wood in artistic stained and enameled effects. Gives practical suggestions on making your home artistic, cheery and inviting. Tells just what materials to use and how to apply them. Includes color card—gives covering capacities, etc. Use coupon below.

JOHNSON'S WOOD DYE

With Johnson's Wood Dye inexpensive soft woods, such as pine, cypress, fir, etc., may be finished so they are as beautiful and artistic as hardwood.

Johnson's Wood Dye is very easy to apply—it goes on easily and quickly, without a lap or a streak. It penetrates deeply, bringing out the beauty of the grain without raising it—dries in 4 hours and does not rub off or smudge.

Full instructions for finishing all wood—old or new—soft or hard, are given in the book.

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Please send me free and postpaid your Instruction Book on Home Beautifying and Wood Finishing.

The best dealer in paints here is.....

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New Blueprint Shows Details of This Useful White-Enameled Kitchen Cabinet

IF your kitchen lacks an up-to-date white enameled kitchen cabinet, with all the latest improvements for lightening the housewife's work, why not make one? Complete working details and a bill of material are contained in Blueprint No. 5 prepared by the Home Workshop Service Department and now ready for distribution.

One special feature of the Home Workshop kitchen cabinet is a self-contained seat, which can be drawn out when dough is being mixed or other culinary operations are being performed at the work counter or on the breadboards.

Another attractive feature is the roomy china closet occupying the middle section of the top of the cabinet. A platter, a jug, and a bowl or two on the lower shelf, a row of cups hanging beneath the upper shelf, and a few plates in the upper section, behind the glass doors, give a colorful and decorative touch to the cabinet that at once raises it above the ordinary kitchen cabinet and makes it a piece of real furniture.

This fine-looking cabinet will save the housewife many steps

The cabinet is 5 ft. 8 in. high, 4 ft. wide, and 2 ft. deep in the bottom section. The top section is 14 in. deep.

The top section contains, beside the china cupboard, a flourbin and a closet for sugar, spices, and coffee. An ordinary commercial flour-sifter is placed beneath the bin as an outlet for the flour, so that the flour may be sifted directly into the mixing-dish. The center door is glazed; the other two are paneled with three-ply veneer. The space between the top of the counter and the bottom of the upper section is 10 in.

Beneath the counter are two breadboards that slide out when needed, thus adding plenty of working space. The top drawer of the bottom section is divided into compartments for kitchen cutlery and silver; the second drawer, which is deeper, is a general utility drawer. The lowest and largest drawer is for bread and cake. It is entirely lined with tin and has a sliding galvanized-iron cover. An adjustable ventilator is provided for this drawer at the side.

The right half of the lower section is a large cupboard with one shelf and a rack inside the door for lids.

The necessary sugar, coffee, and spice containers to complete the cabinet may be purchased or made from jars and tins, to suit individual requirements.

Since the cabinet is intended to be enameled inside and out, any suitable wood may be used. The panels are best made of three-ply veneer, but solid panels may be used if any difficulty is experienced in obtaining the plywood. The only change necessary in the design would be to use a muntin in the door of the lower section, so that it would have two narrow vertical panels instead of a single large panel.

A list of materials giving the exact sizes of each piece is on the blueprint.

In finishing, give two coats of flat white and two coats of a standard white or cream enamel. If, for any reason, a natural finish is preferred, use a good varnish stain.

If you are interested in making this cabinet, fill out the coupon below and send it with 25 cents to the Home Workshop Service Department, POPULAR SCIENCE MONTHLY, 225 West 39th St., New York. Be sure to check on the list the particular blueprint or blueprints you desire.

Next month working drawings of a shaving-stand will be provided in the blueprint series.

Blueprint of Radio Receiving Set Ready for Distribution

IN response to many requests from readers, the Home Workshop Service Department has prepared a blueprint giving full details of a radio receiving set with two stages of amplification.

This set has been designed especially to receive broadcasting programs with maximum clearness and is as good a set as any wireless amateur is likely to need. It can be assembled from purchased parts for about $40 and will equal in amplification and ease of adjustment commercial sets that cost three times as much.

Instructions for making and assembling the set will be found on page 76. They are intended to be used in connection with the blueprint.

The blueprint—which contains the panel details, wiring diagram, and a complete bill of materials—may be obtained by sending 25 cents to the Home Workshop Service Department, POPULAR SCIENCE MONTHLY, 225 West 39th Street, New York.

Coupon for Ordering Blueprints

Home Workshop Service Dept.

Popular Science Monthly
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GENTLEMEN:

Send me the blueprint, or blueprints, I have checked below, for which I enclose . . . cents in stamps or coin:

No.	*Title*	*Price*	*Check Here*
1.	Sewing-Table	25c	☐
2.	Smoking Cabinet	25c	☐
3.	End Table with Book Trough	25c	☐
4.	30-ft. Monoplane Glider	50c	☐
5.	Kitchen Cabinet	25c	☐
6.	Radio Receiving Set	25c	☐

Name.....
(Please print)

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City and State.....

What Is Your "Best Idea" for the Home Workshop?

TWO prizes—$15 and $10—will be given next month for the "best ideas" contributed to the Home Workshop Department. These will be paid in addition to regular space rates.

There is probably not a single reader of POPULAR SCIENCE MONTHLY who has not run across just the sort of idea that would win a prize.

Keep your articles as short as possible and illustrate them with sketches or photographs, or both.

The May prize-winners are:

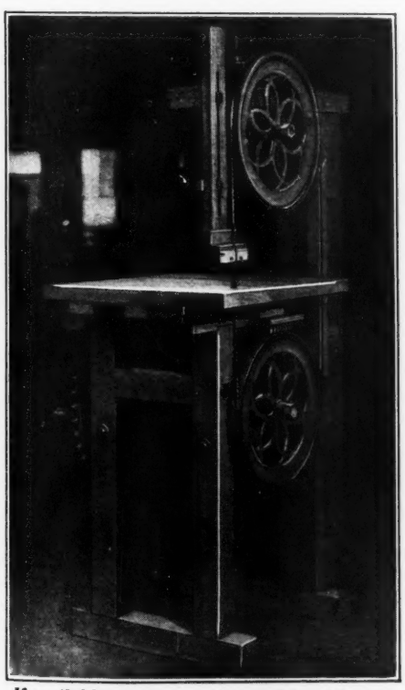
FIRST PRIZE, $15: **Oscar M. Anderson**, Spokane, Wash.: "Automobile Connecting Rods Used in Making Ingenious Bench Machine," on page 92.

SECOND PRIZE, $10: **J. W. Gilbert**, Owensboro, Ken.: "Folding Pullman Breakfast Board Saves Housewife's Steps," on page 98.

The present "Best Idea" prize contest will be concluded next month, to be followed immediately by a similar contest.

Building a Simple Bandsaw

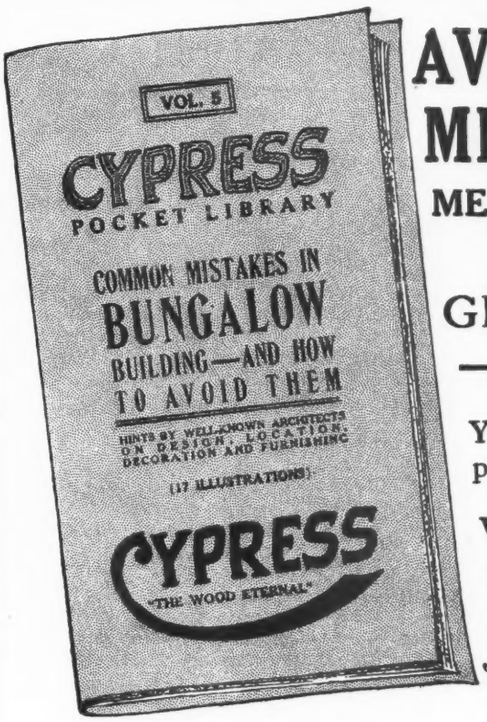
THE frame of this machine is made of "four by fours" with the exception of the king post, which is 6 by 8 in. The



If available, power may be used for this saw

timbers are fastened together with 5/8 by 8 in. lag screws.

The wheels were from an old bone-cutter. To regulate the tension on the saw, the upper wheel is arranged so that it can be raised or lowered.—T. D.



AVOIDING MISTAKES

MEANS SAVING MONEY.

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When Everybody is Urging You to "Build Now,"

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We manufacture Cypress lumber—**and** are proud of that fact. BUT—we don't want you to use Cypress except where **Cypress**, "The Wood Eternal" is *best for you.*

PROBABLY THE BEST THING FOR YOU TO DO *is to write* us for a copy of Volume **5** of the internationally famous Cypress Pocket Library. AND PROBABLY YOU WOULD BETTER "DO IT NOW."

You might as well ask for **Vol. 5,** and at the same time ask for **Vol. 1,** which contains a full list of the 40 odd volumes in this Library (which has become a sort of American Lumber Classic) and which also contains the unabridged U. S. Govt. Rept. on "The Wood Eternal"—what it is, and why you need it—and with some ideas as to why you have to insist on it to get it—also why it is so well worth insisting on. (That's the only way to get anything worth while—isn't it?)

Let our ALL-ROUND HELPS DEPARTMENT help YOU *MORE.* Our entire resources are at your service with Reliable Counsel.

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Insist on **TRADE-MARKED** Cypress at your local lumber dealer's. If he hasn't it, *LET US KNOW*

WIRELESS

The Most Fascinating Study in the World

THIS is the wireless age. . . . . No longer is this miracle means of communication used only to send out S. O. S. messages of distress.

Do you know that "there are nearly half a million wireless enthusiasts in this country and that the thing has only started?"

Not only is the news of the world flashed from city to city and from continent to continent, but lectures, speeches, and even concerts are carried to the four corners of the earth by radiophone.

An operator in New York recently gave a concert that was heard by 100,000 people, as far south as Cuba and 800 miles out at sea!

Wouldn't you like to become a wireless expert? Wouldn't you like to "listen in" on the world's news—to be close to history in the making? You can!

The International Correspondence Schools will teach you everything you need to know about wireless. Best of all, you can learn at home—quickly and easily—in an hour a day of the spare time that now goes to waste.

You will not only learn the code and how to receive and send, but you will learn how to construct and install your own apparatus.

And the course is so simple and easy to understand. It goes right to the meat of the thing. You are not burdened with theoretical discussions that are of interest only to research engineers and designers.

Now is the time to get into this wireless game—not only for your own amusement but as a business. Wireless experts are always in demand—on land and on sea—at good salaries.

This is all we ask:—

Just mark and mail the coupon and let us send you complete information about the I. C. S. Radio Operator's Course or any of the 300 other I. C. S. courses.

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Persons residing in Canada should send this coupon to the International Correspondence Schools Canadian, Limited, Montreal, Canada.

DON'T SWEAT OVER A KITCHEN STOVE!

No excuse any more for fussing and fuming over a hot kitchen stove in summer time! No need of keeping a hot fire going all day just to do a little cooking. Amazing new invention does away with this dirt, muss, and kitchen drudgery.

Amazing Invention

Gives plenty heat *when you want heat.* You turn it off instantly *when you don't want heat.* Cheaper—Burns 95% air—5% oil. Saves money, time, labor, health. No fires to make, no ashes, dirt, smoke, odor, chopping, shoveling, carrying dirty coal or wood.

Quick Heat On or Off at Turn of Valve

Don't let your coal-and-wood stove turn your kitchen into a roasting-room. Wonderful invention—Oliver Oil-Gas Burner gives quick heat at turn of valve. Fits in fire box without adjustment. Note how simply it works. Absolutely safe. Lasts lifetime. Fine all seasons. No roasting Summer kitchen. Ready heat in chilly Fall and Spring. 8 times more heat in Winter. **FREE BOOK** telling all about the "New Kind of Heat," sent free. Also amazingly low introductory-price offer including 30-Day Trial. Write today. **OLIVER OIL GAS BURNER & MACHINE CO.,** 2007-E Pine St., St. Louis, Mo. Oldest, Largest Manufacturers of Oil-Gas Burners in the world.

AGENTS Oliver agents earn as high as $500 a month—$25 a day spare time is easy. Exclusive territory. Big all-season seller. Write for Special Offer.

THE HOME WORKSHOP

Drawing Machine that Enlarges Will Delight the Kiddies

CHILDREN will find unlimited amusement in copying pictures with the aid of a drawing-machine. This device, which can be quickly and easily made in the home workshop at little or no cost, is based upon the principle of a fixed pantograph. With its use the copy will be made very much larger than the original, so that the children will be encouraged to make big, bold drawings and will, therefore, learn much more than they do by the usual methods of tracing or filling in outlines that have been printed on drawing-cards or in copybooks.

First make a drawing-board of any convenient size to suit the materials at hand,

The machine works like a pantograph

or obtain an old drawing-board or table-top that will serve the same purpose. Mount it easel fashion by screwing two legs to the back and hinging a longer support near the top at the back. To prevent this rear support from slipping, tie it to the front legs with chains or cord so that the whole will stand rigidly. The pantograph is made from four strips of hard wood, as shown in the illustration. It will be seen that they enclose a parallelogram. Be sure that the two long sides of the parallelogram between the pivot points are precisely alike in length, and that the two short sides are equal, because any error in these lengths will cause more or less distortion in a drawing.

The tracing point is made from a dowel and pointed, but it should not be so sharp as to prick and tear the copy. It serves as the pivot for that corner of the parallelogram, the other pivots being simply screw-eyes. The drawing-point may be a pencil or crayon, the latter being advisable for smaller children.

In using the machine, the child copies the object boldly and watches the movement of the tracing point, which guides him in estimating the direction and length of his lines.—JOHN CALLAHAN.

A WHITEWASH recipe of the U. S. Bureau of Lighthouses is said to be good for outdoor exposure. Slake ½ bushel of unslaked lime with boiling water, keeping it covered during the process. Strain it and add 1 peck salt, dissolved in warm water; 3 lbs. of ground rice in boiling water, boiled to a thin paste; ½ lb. of powdered Spanish whiting and 1 lb. of clear glue, dissolved in warm water; mix these well and let stand for several days. Keep the wash thus prepared in a kettle or portable furnace; and when used, put it on as hot as possible, with painter's or whitewash brushes.

WIRELESS TELEPHONE

Broadcasting stations are now in operation at important centers all over the country. *YOU* can easily receive these interesting daily programs with an *ABC* wireless receiving *UNIT. ABC UNITS* come to you ready-to-operate and complete in every detail. They are built on the sectional system, so that you can increase the range of your station at any time.

Ask your radio or electrical dealer about this and other exclusive features of *ABC UNITS.* If he cannot supply you, send us his name and address and enclose ten cents, for a copy of our booklet, "How I Put Up a Complete Radio Station in Two Hours." Request Booklet C5.

Jewett Mfg. Corp., 21 E. 40th St., N. Y. C.

ABC UNITS — Standardized Radio — Sectional Beginning

SELL US $ YOUR SPARE TIME $

We will train you to write show cards. No canvassing or soliciting; we supply you with work; distance no object; you can earn from $15 to $50 a week.

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MAKE YOUR FORD INTO THIS SPORT CAR Patterns Life Size Red-i-Kut $6.40

Keen, Classy Up to the minute

Other types down to $3.50. Life size patterns and simple instructions show all details. Materials from hardware store and spare time work complete job at quarter factory cost. Order NOW from this ad. Illustrated prospectus showing bodies, tops, windshields mailed for 5c coin.

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SEND FOR BOOKLET SHOWING PHOTOS OF MEN WITH AND WITHOUT

The Perfect Leg Forms

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Used and rebuilt motorcycles; single and twins, $25 to $100. Used bicycles, $5.00; tandems, $10. All machines guaranteed in good working order. New bicycles and motorcycles at Factory prices. You save dealers' profits. Motorcycle and automobile tires too, $3.00. Complete line of parts and supplies.

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FOR FORD and CHEVROLET CHASSIS

"THE FOURSUM" illustrated above is a cozy, convertible four passenger complete with "Fiat type" radiator and a massive hand hammered German silver shell. Makes driving a pleasure. Other roadster, touring and speedster designs. Big cut in prices. Bodies as low as $29.50. Territory open for live wire dealers and agents. Make real profits. Write for our catalogue.

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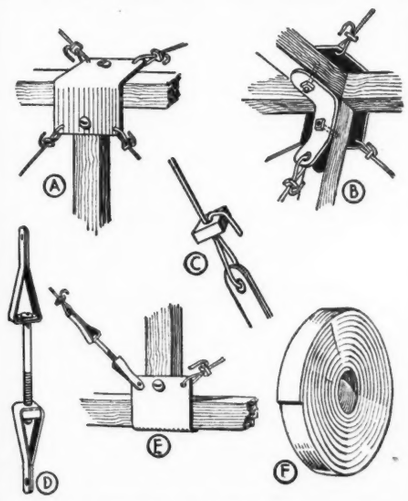
Federal Auto Body Co., Toronto, Ont.; Campbellton, N. B.

THE HOME WORKSHOP

Tested Constructional Details Will Help Glider Enthusiasts

EXPERIMENTERS with gliders of one kind and another—and there will undoubtedly be a good many of them this summer—may find the following hints on construction of some value. They are ideas I have found satisfactory in many years of experience in building the different types of gliders, toe flight machines, motorless, and powered machines.

A simple method for connecting the struts and longerons used in fuselage construction are shown at *A* and *B*. The fittings are made of sheet iron and serve as a five-way terminal. The outside fitting



Useful hints for building light planes

(*A*) has four of the terminals and the inside fitting (*B*) has the fifth terminal. The bolts are 3/16-in. stove bolts. This is an inexpensive joint for a glider of light construction.

The use of a common nut in place of a wire lock or ferrule is shown at *C*. A shoe eyelet is placed in all terminals so th t the wire will not be cut by the sharp m tal edges.

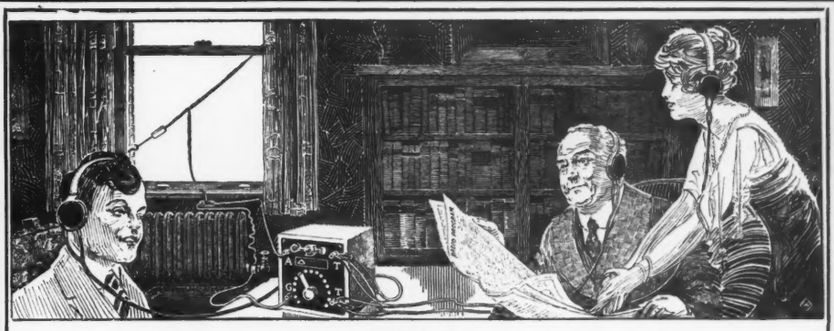
A turnbuckle made from either a 3/16- or a ¼-in. stove bolt, two pieces of strap iron, a washer and a nut, is illustrated at *D*. Ordinary pliers or pincers are used in turning the turnbuckle, which should be painted around the threads and nut or wrapped with tape to prevent its being loosened by vibration.

At *E* a rivet is used to fasten the turnbuckle to the longeron fitting.

The rubber shock absorber pictured at *F* is made from old inner auto tubes. Cut off both edges of the tubes and roll up the strips until the desired size is obtained. That will vary with the weight of the machine. Mark just where the end comes on the completed roll, then unroll and vulcanize the other end, leaving a hole for the axle. Then reroll and vulcanize the outer end. Two of these will serve in place of the old-style Farnum shock absorber and are cheap and easily made.—CARL H. DUEDE.

He Crossed Channel on Bicycle

A NATIVE of Croydon, England, Harold A. Rigby, has crossed the English Channel from Dover to Calais on an "amphibious bicycle" driven by a propeller and supported by floats. The machine was his own invention.



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Remember—reputation and a guarantee of dependability are built into every Freed-Eisemann unit by the same engineering skill that designed radio apparatus now used by the U. S. Navy.

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A LUXURIOUS SEDAN The Wonderful ALL-YEAR CAR—Electric STARTER and LIGHTS—Drive Your Own Car
Join our great Auto Club and win Grand Prizes including Ford Sedan! Can you make out two words spelled by figures in picture? The alphabet is numbered—A is 1, B is 2, etc. What are the two words? Other valuable prizes and hundreds of dollars in cash given. Everybody wins! So easy you will be surprised. We're already given away many Autos. Why not you? Send answer today.
1 21 20 5 / 6 18 5 5

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Motor is ¼ h-p (not 1/6 or ⅛ usually put onto grinders) totally enclosed and dust-proof: 110 or 220 volt AC—60 cycle operating at 1740 rpm—just the right speed for the large diameter wheels, to do best work without danger of burning. Motor is guaranteed for 1 year by the manufacturer.

Ideal for Hotel, Restaurant and private homes, for grinding tools, cutlery and burnishing silverware. Large enough for public garages and machine shops.

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Motor alone with one one-half inch grooved pully is offered for $13.50 or just about half usual price.

Send cash with order, or we will ship C.O.D., anywhere in the United States, if preferred.

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Wound with commercially pure enameled copper wire—resistance 2000 ohms. Adapted for use with any type or make of Radio Receiving Outfit.

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Keeping the Home Shipshape

How to do the odd jobs that save time, temper, and money

To Refinish Floors

REFINISHING floors always seems a formidable task, but hardwood flooring will give lasting satisfaction if treated in the following simple manner:

Mix genuine boiled linseed oil (it must be genuine to be thoroughly satisfactory) with pure spirits of turpentine in the proportion of 2 teaspoonfuls of turpentine to a common saucerful of boiled oil. Rub well into the floor with a piece of sponge or cloth free from lint. Wipe off any oil that does not soak in.

If the process is repeated as soon as the bare grain of the wood again begins to show, a fine rich dark floor, permanent in character, will be obtained. A slight rubbing with the same mixture will keep it in good condition.

An ordinary plain North Carolina pine flooring laid ten years ago, to which nothing else has been applied, always appears like a finely finished old oak floor. Although the flooring will darken by itself with age and repeated oilings, a little coloring matter may be added to the first oiling to hasten the process.

The floor may be used at once by laying sheets of paper down where it is walked on. The oil will dry in one day.—L. D.

Re-Puttying Windows

REMOVE all the loose putty, first testing it well with the putty-knife, for often some that looks right will come off at a slight touch. With a little paint or linseed oil touch up all these places and re-putty. This will ensure a lasting job.—F. M.

The Care of Screens

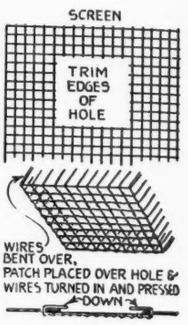
BEFORE putting up the mosquito or fly screens for the summer, take them out into the open air and brush them well. If any are very rusty, test them by pressing against the wire firmly with the fingers. If the wire does not give way, it probably is good for another season.

If there are any small breaks in the wire, cut some pieces of netting about 1½ in. square. Unravel the four sides of the pieces about four strands, turn up the projecting points at right angles on all sides and push this patch over the break. The points will then come through on the other side and, on being turned down and pressed against the wire, will hold the patch securely in place. It will look neat and outlast the screen.

If there is a tear along the edge of the screen, remove the small molding that covers the tacks, take out the tacks along that side, stretch the wire, and retack it. If the slack does not allow of doing this, a new piece of wire is required.

To remove old wire, take off the molding covering the tacks, pull out a few tacks at one corner only, hold down the frame firmly with the left hand, and catching hold of the loosened wire at the corner, give a sharp upward pull. The entire piece of netting will come off.

Lay the new piece of wire on the frame, tack it down along one side and stretch and tack the opposite side. Then, without much stretching, tack along the third side. Stretch tightly when tacking the last edge. Trim with the point of a sharp penknife and replace the molding.



To paint, make a mixture in the proportions of 1 saucerful of genuine boiled linseed oil to 2 teaspoonfuls of turpentine. Add a little black coloring if you wish.

A compact piece of fine sponge about 3 in. square, trimmed at the edge so as not to smear the frame, will be found an excellent substitute for a brush. An old glove may be used to protect the fingers.

The same boiled oil and "turps" will refresh the frames if oil finished.—A. E.

Replacing Lost Keys

FREQUENTLY, when a key of a bathroom, bedroom, or other room has been lost, it is not replaced because of the difficulty of getting a carpenter or locksmith to the house. Why not learn how to remove a lock yourself, so that you can carry it with you the next time you go into town and have a key fitted at any hardware store?

To remove the lock, unscrew the small screw in one doorknob so that the other knob and the spindle to which it is attached may be pulled out. Then unscrew the two screws in the edge of the door, and the lock can be pulled out by using the bolt as a handle. If it sticks, a slight pry with the screwdriver will help it out. To prevent marring the door, pry where the handle of the door goes through, never from the edge of the door. It is well to put the screws back in the spindle edge and the door, so that they will not be missing when the lock is returned.—R. B.

Sagging Doors

OFTEN when the hinges of a door that has been dragging on the floor have been screwed up again with longer or stouter screws, the trouble will develop anew in a short time. The reason usually is that there is no wood in which the screws can take hold.

Two reliable methods of fixing such a door are as follows:

The better way is gently to pry off the door-casing on the side on which the hinges

(Continued on page 89)

TO get the most pleasure out of wireless you will want a loud speaker. Then you can entertain a group of friends—hear the wireless telephone programs clearly all over the room—actually dance to wireless music—just like a phonograph.

All loud speakers require vacuum tube amplification. The heart of the amplifier is the transformer.

ACME Transformers

have been brought to a high degree of efficiency through years of specialization on this one product. They amplify wireless telephone without detracting from the original tone value.

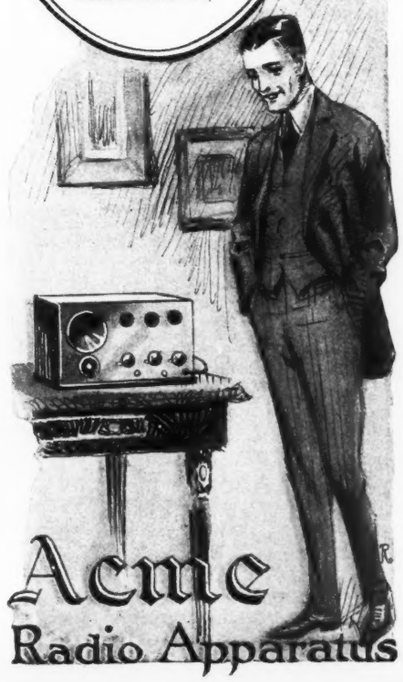
Acme transformers are for sale separately and also incorporated in complete Acme Instruments.

The **ACMEFONE**, illustrated below, is a complete long range installation. It includes in one handsome cabinet, the tuner for selecting the particular station you want to hear, the equipment for three vacuum tubes to amplify (or magnify) the sounds, and a loud speaker which sends the voice and music clearly all over the room. The price is only $80.00. The only additional equipment you will need is an aerial, three vacuum tubes, two "B" batteries and a storage battery. The work of installation has been reduced to the mininum. Simply put up a simple aerial, insert tubes, hook on batteries and you are ready to listen.

Other Acme Apparatus includes vacuum tube detector and amplifier equipment, designed to hook on to your present receiving equipment and prepare the way for a loud speaker. Acme apparatus is backed by the reputation of the oldest manufacturer of transmitting apparatus in the country and is for sale at all radio dealers.

ACME APPARATUS CO.

Transformer and Radio Engineers and Manufacturers



Acme Radio Apparatus

The Shipshape Home

(*Continued from page 88*)

are. This is the plain or ornamental piece of wood that covers the space between door-jamb and the plaster. It will at once be seen that there is an open space behind the door-jamb, and the hinge screws will be seen sticking through into this open space instead of into solid wood. Remove the screws and put a block of wood about 8 in. long opposite each hinge. Replace the hinges, and the screws will have a perfect grip. Before replacing the casing, draw the nails from the back with pincers so as not to mar the face side. Nail it on again carefully with finishing nails. Set them with a nail set, and stop the holes with putty colored to match the trim.

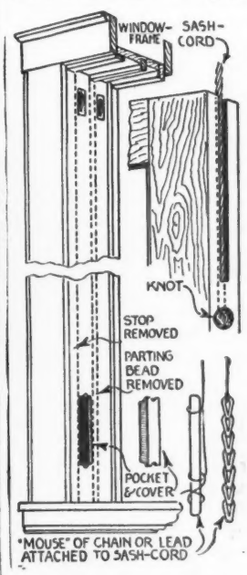
The second method is to drill two extra screw holes in the hinge and countersink them. Place them so that the new screws will go into the door casing or trim. The old screws should be put back with the aid of plugs for appearances' sake.—A. E. E.

Replacing Sash Cord

To replace a broken sash cord is not difficult if you know just how to proceed. First of all, take off the inside stops and remove the parting beads. This task may be complicated by the fact that they are stuck fast with paint, so try tapping them sharply with your hammer, being careful to protect the face of the wood with a small block of wood.

Remove the weight pocket, which is usually held in place in modern wooden frames by the stop, parting bead, and two screws. The weight will then be exposed and it can be removed.

Make a carpenter's "mouse" by tying to a piece of string a small curved piece of lead, a chain, or anything that suggests itself for use as a weight, and drop it over the pulley, down behind the frame to the pocket opening. Then pull the new sash cord over the pulley after it. Fasten the weight securely to the sash cord and draw it up as far as it will go, cutting the cord just long enough to allow the sash to rest on the window-sill with the weight in that position. There should be hardly more than an inch of slack.



The cord is run into the sash as shown and knotted at the end. Be sure to get proper sash cord from the hardware store.—G. R. B.

(*Continued on page 90*)

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Save Time and Money

Atkins laboratories have discovered the materials and processes of gas-and-oil tempering to make hack saw blades cut faster and easier—*without breakage.* Prove it on your next job. Send us 10c and tell us the cutting you do. We'll send you an 8- or 10-inch blade. If it isn't the best blade you ever used—your money back.

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THE HOME WORKSHOP

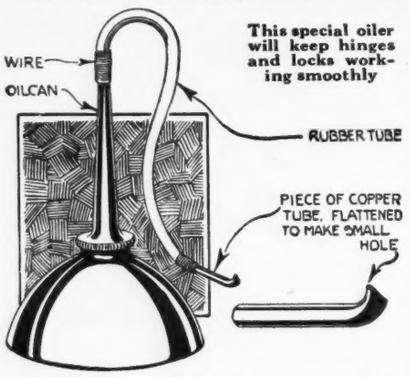
The Shipshape Home

(Continued from page 89)

Oiling Locks and Hinges

VERY often door-locks, padlocks, and hinges do not work well because they need oil. To oil them thoroughly is a simple matter if a special oiler is made by fixing a flexible rubber tube 6 or 8 in. long and a small, bent nozzle to an ordinary oil-can. The nozzle can be made of a piece of copper tubing, flattened at one end and shaped as shown.

To keep the tube in shape while it is being



This special oiler will keep hinges and locks working smoothly

bent, run a wire through it. The hole in the end should be quite small.

To oil a lock, place the nozzle in the keyhole and squirt a drop or so of the best quality machine oil in several different directions, turning the oiler like a key.

The same device may be used for oiling hinges and any inaccessible parts of small machines.—J. S.

Using Steel Wool

FREQUENTLY the home mechanic is asked to repair cooking utensils. This is often difficult, especially if the hole is irregular in shape. The easiest way is to fill the hole with bright steel wool, after cleaning the edges thoroughly, and hammer it as flat as possible. Moisten the wool with soldering fluid and apply the solder as usual. This makes a good plug that is not likely to come off as easily as a patch.—DR. WALTON HAYDON.

Painting Metal

OFTEN paint does not seem to "stick" well to tin or other metal roofing, galvanized iron gutters, and rain-spouts. Usually this is because a very thin film of grease has been left on the material.

Before painting a tin roof, scrub it clean with soap and water or with cloths moistened with benzine. Allow it to dry thoroughly before applying the paint.

The same method may be used with galvanized iron, but the better way to treat it is to let it stand exposed to the weather for some time before painting.—M. R.

Taking Down Pictures

SOMETHING that I have found very useful is a device for taking down pictures without having to climb up and down a ladder. It is just a broomstick with a good-sized nail driven in near the end and bent upward to form a hook.—C. B.

(Continued on page 91)

Voices thru the air

Enjoy the thrill of wireless telephone every day right in your own home. Listen to concerts, dance music, news, sporting results, crop reports, time signals, etc., sent free of charge from the big broadcasting stations.

Get our new handsomely illustrated book "Wireless Telephone in Your Home." It tells in non-technical language just what you want to know about wireless. It shows the locations of all the principal broadcasting stations. It illustrates and describes modern inexpensive receiving outfits that you can operate without previous experience. Send 25c. for your copy today.

Where's the nearest mail box?

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How To Conduct a Radio Club

BY E. E. BUCHER. Covers parliamentary procedure, indoor and outdoor experiments, 5,000-mile receiving sets, vacuum tube amplifiers and detectors and many other subjects. Paper Cover. 148 pages. Fully Illustrated. Price 75c

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Think of it! You pay little more than rental, and the machine is yours! We offer the same three models of the Underwood Typewriter which are being made and sold by the Underwood Company today. The only difference is that Shipman-Ward machines are priced lower and are rebuilt like new by experts. You can't tell them from brand new machines. Visible writing—the FULL LINE of typewriting is visible at all times. STANDARD 4-ROW SINGLE SHIFT KEYBOARD. Two color ribbon, back spacer, stencil device, automatic ribbon reverse, tabulator, etc.

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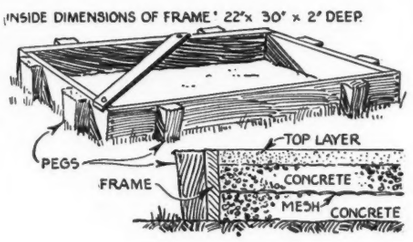
THE HOME WORKSHOP

The Shipshape Home

(Continued from page 90)

Concrete Slabs

SLABS of reenforced concrete, which can be made quickly and easily at a trifling cost, will be found useful in many places around the garden and poultry yard and sometimes may even be used as a substitute for a concrete walk. By actual test I have found them successful. Originally they were made in connection with a chicken house and then, when no longer required for that purpose, were removed to the outside of several back doors where no concrete had been laid. They were set about 2 in. below the doorsill and the earth brought up level round the slab. No noticeable change has taken place through



the frosts of several very severe winters. To lay a cement walk in the customary way usually requires a mason, but by this method no one need go without the comfort of always having clean steps and walks.

Make a frame of 1 by 2-in. lath, using two pieces 22 in. long and two pieces 32 in. long. Square the frame carefully and nail a brace across one corner. Place it on the ground and drive in pegs to hold it in place. The brace can then be removed.

Of 5 parts of sandy gravel and 1 part of Portland cement make a dry mixture, sufficient to nearly fill the frame. Mix this until it is about the consistency of soft butter on a mixing-board made of some planks nailed together. Fill the frame about half full, lay in a piece of chicken wire or wire mesh to serve as reenforcement, and continue filling the frame almost to the top.

Screen a little sand through fine wire mesh, about ¼ in., and make a new batch of concrete in the proportions of three of sand to one of cement. Fill the frame up to the top with this mixture before the coarser concrete underneath has had time to harden, and draw a straight edge across to level the block smoothly.

The frame may be lifted off in a few days and used over again, but the slabs should remain unmoved for a few weeks to allow them to season.—A. E.

To Make a Force Pump

NOT having the tools with which to relieve a congestion in the drain-pipe of a kitchen sink, I used a discarded circular pasteboard box that had contained a cereal. The box was placed over the sink strainer, open end down, and given a sharp downward blow and the pressure forced out the obstruction. Since that time I have used the same kind of a box in clearing other drains.—E. H. HAZLEWOOD.

The Mistakes

That ruined millions of teeth

We offer you here a ten-day test which will change your ideas about teeth cleaning.

The old methods failed to end film. So millions have found that well-brushed teeth discolored and decayed. Now dental science has corrected those mistakes, and we urge you to see the result.

Film—the great enemy

That viscous film you feel on teeth is their great destroyer. It clings to teeth, gets between the teeth and stays. It dims the teeth, then may foster attacks on them. When you leave it, night and day it may do ceaseless damage.

Film absorbs stains, making the teeth look dingy. It is the basis of tartar. It holds food substance which ferments and forms acid. It holds the acid in contact with the teeth to cause decay.

Millions of germs breed in it. They, with tartar, are the chief cause of pyorrhea. Also of many diseases.

A daily combatant

Dental science has now found two effective film combatants. Able authorities have amply proved them. Leading dentists everywhere endorse them.

Both are combined in a dentifrice called Pepsodent. Millions of people have come to employ it. And glistening teeth, half the world over, now show its delightful effects.

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THE HOME WORKSHOP

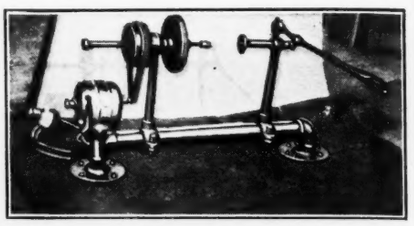
Connecting Rods Used in Making Ingenious Bench Machine

By Oscar M. Anderson

(First "Best Idea" Prize for May)

I HAVE built and am using continuously in model making a small bench lathe, drill, and grinder that is constructed mainly from auto parts.

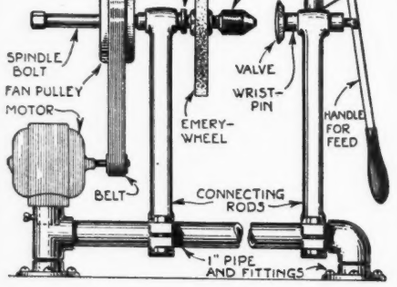
The base is made of about 18 in. of 1-in. pipe, two floor flanges for 1-in. pipe, a close



Many combinations are possible with this small lathe

1-in. nipple, and a 1-in. tee. The headstock is a Ford connecting-rod, the bearing a front spindle bushing, the shaft a spindle bolt left long for the attachment of polishing-wheels, and the pulley a Ford fan pulley. A nut sawed in two holds the emery-wheel. The drill chuck is made from a 10-cent tap holder filed and screwed into the nut that holds the emery wheel.

The tailstock is another Ford connecting-rod, with a Ford wristpin for a center. An



Head and tailstock are connecting rods

old valve-stem through the center makes a rest for drilling. A link and handle provide an adjustable feed, and a thumbscrew clamps the center when it is desired to have it fastened rigidly.

To make a good toolrest for the machine, take another Ford connecting rod with a wristpin in it and connect it between the headstock and the tailstock. A small arbor and a set of wheels obtained from a dentists' supply house may be used for grinding small gears and getting into close corners. Fasten the arbor in the drill chuck. With this attachment, keys of all kinds can quickly be made.

New soles and heels for shoes may be dressed down quickly by clamping emery cloth with a wooden wedge to a slotted pine cylinder 1½ in. in diameter and about 3 in. long. An attachment for sharpening safety-razor blades may be made in the same manner, using a somewhat shorter block covered with leather from a discarded kid glove.

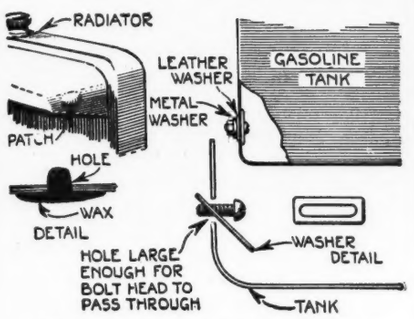
Power is supplied by a small electric vibrator motor from which the handle has been removed. The motor is set in one end of the tee.

THE HOME WORKSHOP

Making Emergency Repairs to Gas Tank or Radiator

SHOWN in the illustration are two emergency repairs which are suitable for stopping leaks in gasoline tanks or in radiator tanks without soldering, when the hole is located in the tank at a position that makes it inconvenient to apply solder.

The quicker method is to apply a wax plug, though this is not to be considered a permanent repair. This is done by heating



These patches may be quickly applied

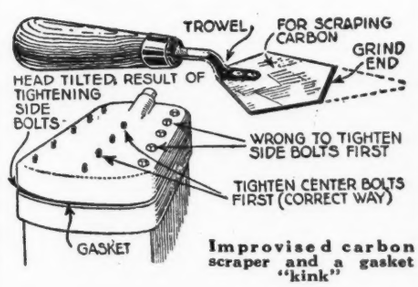
a file or any flat tool over a flame and digging out a lump of the sealing-wax from the top of a dry cell with this heated tool. While the wax is soft it is immediately applied to the hole and pressed down firmly and about ½ in. around the edge.

The second method is by means of a bolt, nut, leather washer, and a special elongated washer. The hole is made just large enough to pass the head of the screw-bolt through. The washer is inserted endwise on the body of the bolt and pushed up through the hole. The leather washer is placed over the bolt and the nut screwed on tight, using a small circular washer under the nut. This makes a substantial repair and can be made tight at any time.—G. A. LUERS.

Two Hints to Help You in Overhauling Your Car

NEARLY every car-owner has to hunt for a tool of some kind for scraping away the carbon after the cylinder head is removed. A tool for this purpose with a handle is convenient to use.

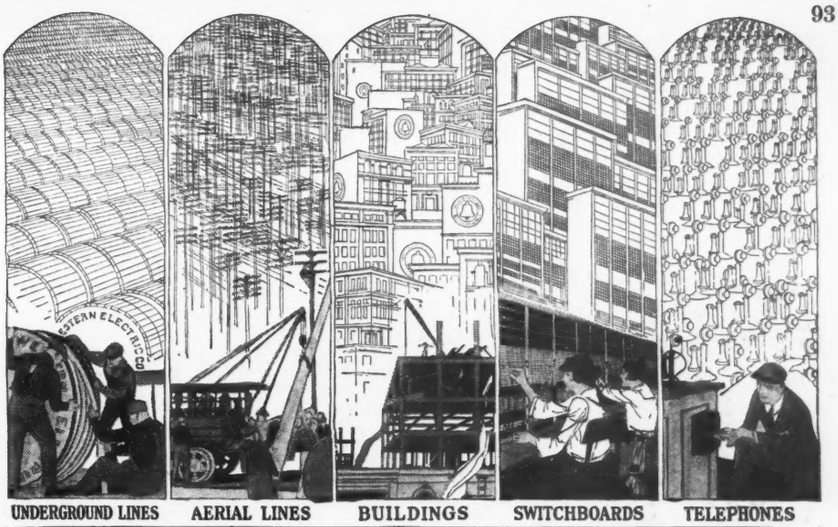
An old trowel with the point broken and sharpened forms a tool which is handy for



Improvised carbon scraper and a gasket "kink"

scraping the carbon from the piston-heads and cylinder head. When cleaning the grease and dirt from the engine-pan and about the springs this tool is equally useful.

When replacing cylinder heads, it is important to tighten down the center row of bolts first. Tightening the outer row of bolts at either side results in tilting the head as indicated. The result is either water or compression leakage.—A. G.



Breaking Construction Records

Since 1920, faced with the greatest demand for service in telephone history, the Bell System has surpassed all previous records for the installation of new telephone equipment. In the last two years more than 1,000,000 additional stations have been added to the system by construction. This is equal to the entire number of telephones in Great Britain.

In 1921 alone, 450,000 new poles were placed—enough to make a telephone line from New York to Hong Kong. The aerial wire put into service in the same year, 835,000 miles in all, is enough to string 60 wires on such a telephone line.

1,875,000 miles of wire, enclosed in 1,500 miles of cable, were added to underground and submarine lines in 1921. New underground duct totaling 11,000,000 feet was constructed, this representing approximately 300 miles of subway. 69 new central office buildings and important additions were completed or in progress, and new switchboards with a capacity of many thousands of connections were installed.

This equipment added to the Bell System, great though it is in volume and value, represents but a small part of the vast property which enables the telephone on your desk to give the service to which you are accustomed. And to meet the increasing demands for new service, the work of construction goes on.

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THE HOME WORKSHOP

Help the Bird Conservation Movement by Making a Birdhouse

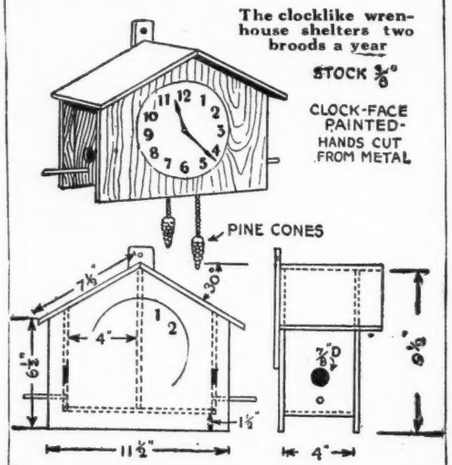
By Gladstone Califf

(If every reader of the Home Workshop will spend the time necessary to make a birdhouse this spring, it will give the present bird conservation movement a great impetus. Suggestions for designing attractive houses are contained in Mr. Califf's article.—THE EDITOR.)

IN making birdhouses, there is endless opportunity for originality. The plain, ordinary boxlike structure that so often serves the purpose of a birdhouse can be made, with a little ingenuity, a really decorative and interesting ornament for any garden.

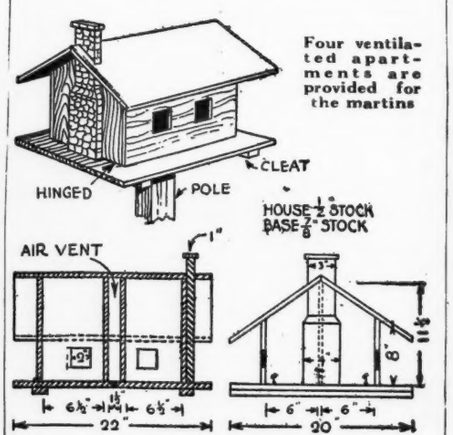
Three designs over which the boys in my classes have become most enthusiastic are shown in the accompanying drawings.

In connection with building wren houses, it should be noted that a pair of wrens raise two and sometimes three broods a year, but never more than one brood in the same



house. The advantage of a double house, therefore, is that after the wrens have raised a brood on one side, they will move to the other. The bottom is hinged and held shut by a hook, so that the house may be cleaned thoroughly each season.

The clock weights are simply large pine cones, painted in colors, such as green, dark red, and yellow in alternate stripes.



They are suspended by means of wire or small chains attached to screweyes. One

(Concluded on page 95)

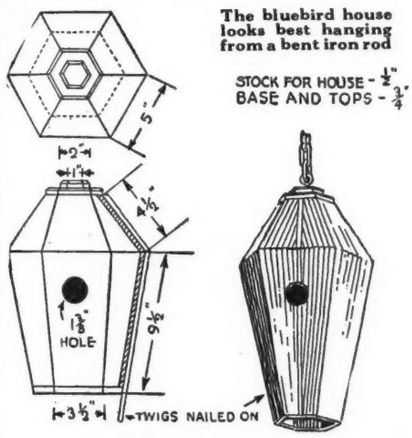
Help the Bird Conservation Movement

(Concluded from page 94)

cone should be a trifle lower than the other. The roof and sides of the house are finished with a dark oak oil stain; the face is painted white with black figures, and the hands are of tin. The house can be hung on a pole or placed on the wall of a building.

The martin house, which should be placed on a pole out in the open, contains a four-room apartment. The openings for the birds are 1¾ in. above the floor. This prevents the young birds from getting wet during heavy rainstorms and also keeps them from falling out. The air vent in the center of the house will keep the rooms dry and comfortable for the birds.

This house also is arranged so that it can be raised up and the floor cleaned out. The roof can be painted green, the floor and sides white, the chimney red, striped with white to represent mortar.

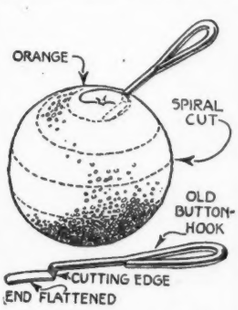


The bluebird house looks best hanging from a bent iron rod

The bluebird house is constructed something like a birdcage and is intended to be hung on a hook attached to a bent iron rod—a Japanese effect. The rod curves up and then down and around the house and is attached to a pole below if it is not desired to extend the rod all the way to the ground. A good location for it is in the center of a circular flower bed. The outside of the house is covered with twigs about ¾ in. in diameter, giving a rustic appearance. The bottom is fastened with three screws so that it can, with very little trouble, be removed for cleaning.

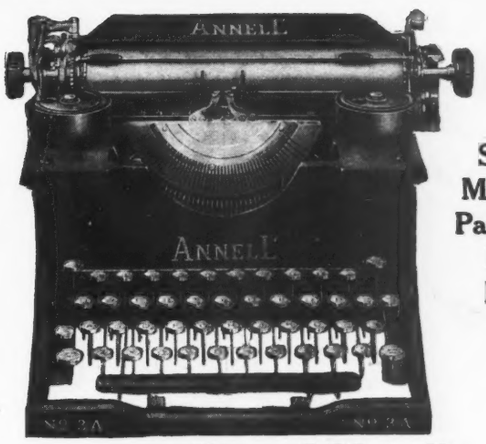
This Orange Knife Removes Peel without Cutting the Fruit

IT is always hard to peel an orange without cutting into the fruit. To overcome this difficulty, I made the simple cutter shown in the accompanying illustration. With its use the skin of an orange can be completely separated from the fruit. It is then taken off by unwinding it in one long strip.



The peel comes off in a long spiral.

To serve oranges prepared in this way, but with the skin still on them apparently intact, is a novelty for the luncheon table.—DAVID E. CRABB.



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THE HOME WORKSHOP

Wood Turning Lathe Constructed with Direct Motor Drive

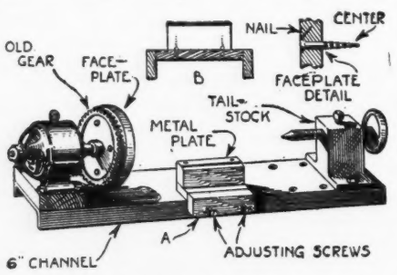
By D. Loren Davis

THIS wood turning lathe was inexpensive and easy to make and has paid for itself many times over. On it I have made pedestals, table lamps, candlesticks, and models of machines in wood, and have done all sorts of furniture repairing.

I have made as many as four boudoir lamps complete on it in one hour.

The bed is a steel channel 4 ft. long, which can be purchased at any steelworks. A 1/20 h.p. 1725 r.p.m. motor was mounted on a block of oak and then securely fastened to the base.

I found an old gear in the junkyard that had a bearing the same size as the motor shaft—3/8 in. I drilled three holes through the gear for wood screws and then fastened the gear to the motor shaft with a setscrew. Next, I cut out a circular piece of wood a little larger than the gear teeth and through the center drilled a countersunk hole to take a large wood screw, which



Although portable, the lathe is solid and sturdy

serves as a screw center. The screw head was drilled at an angle and a small lath nail driven into the wood to keep the screw from turning.

An old casting and a long bolt threaded its entire length, made the tailstock. The bolt was pointed on the end and locked in place by a setscrew. The tailstock was fastened to the base with two screws. Several holes were drilled in the base so that short and long pieces could be turned.

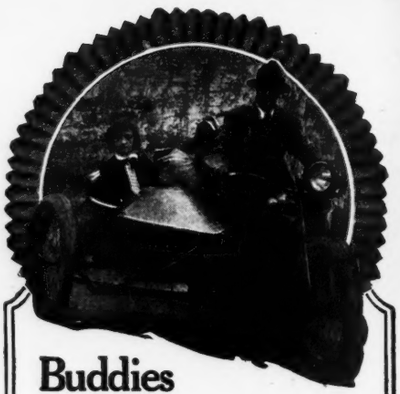
The steady rest was made of oak and the top of the rest covered with a small strip of steel so that the tool would slide easily. This rest is used for turning lengthwise and may be moved along to any point. The wood screws adjust the rest for different diameters.

The rest, shown at *B*, is for face turning or turning crosswise of the base. It is made of oak and has two ends that hang over the base and steady it. The turning tools I made from worn-out files.

This lathe will run without vibration and does not have to be screwed down. This makes it portable and it can be set to one side when using the bench for other work. By using thicker blocks under the motor, tailstock, and tool rests, larger diameters can be turned. The 1/20 h.p. motor will handle work as large as 7 in. in diameter without overloading it.

I have placed a fiber washer on the motor shaft before fastening on the faceplate; it takes up the end thrust when turning against the motor. Another washer is used between the faceplate and the work when I desire to turn the work to the end; this prevents cutting into the faceplate.

The lathe is very handy for winding wireless instruments and polishing parts, as well as for all kinds of wood turning.



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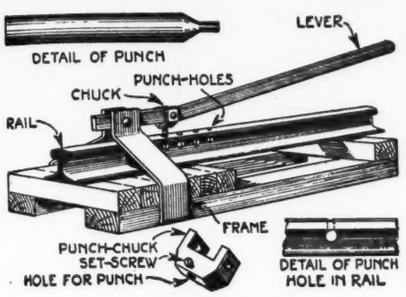
THE HOME WORKSHOP

Constructing a Powerful Punch for the Small Shop

WHENEVER it is necessary to punch a number of holes in sheet or bar metal not more than ¼ in. thick, a serviceable homemade punch may be constructed at little cost.

Obtain a rail about 3 ft. long and drill a series of holes in it 2 in. apart, from 1/16 to ½ in. in diameter, deep enough so that the



A 3-ft. length of rail forms the bed of this cheaply and easily made shop punch

drill is exposed alongside the central web of the rail. This will provide chip holes, although for the very small diameters it may be necessary to drill into the web at right angles to provide chip outlets.

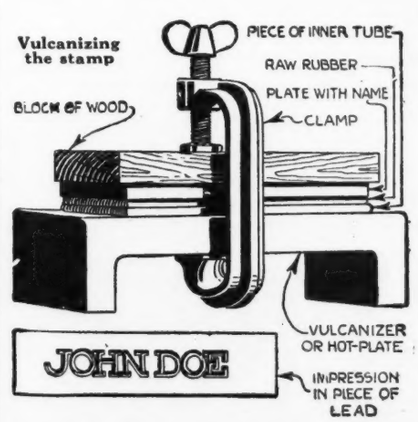
A 5-ft. length of 1-in. wrought bar iron 1½ in. wide forms the lever. This is heated, bent, and attached as shown. The punch chuck is made from a 1 by 2 by 2½ in. block of iron.

The punches are ⅝-in. stock, 5 in. long, tempered or casehardened, depending on the material. All of the bolts should be of high grade steel to prevent shearing.—P. H.

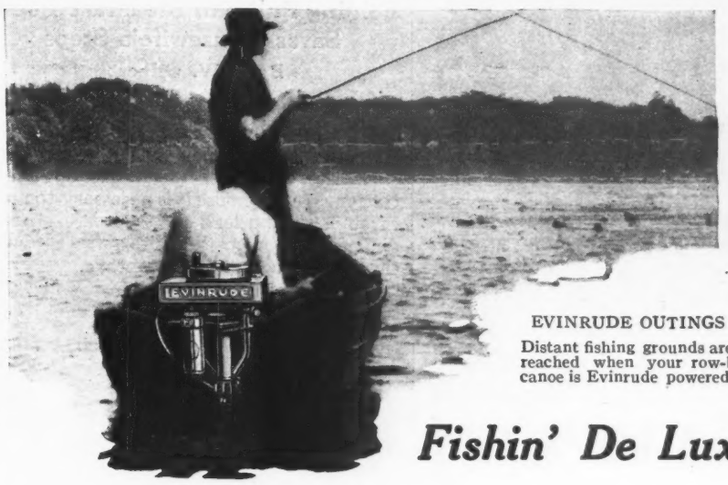
How to Make Rubber Stamps

TO make your own rubber stamps, obtain a flat piece of 1/16-in. lead or copper and with a set of lettering punches and a hammer mark the metal with whatever lettering you wish the finished stamp to have.

Take a piece of old automobile inner tubing and some of the raw rubber used



for mending tubes. After cleaning, place a little rubber cement on the surface side of the inner tube and put the raw rubber on the top of it, then the piece of lead with the impression side next to the raw rubber. Clamp these down tightly with a block of wood on a hot plate or vulcanizer for 20 minutes. Fasten the completed stamp to a block of wood for a handle.—L. H. VOTE.

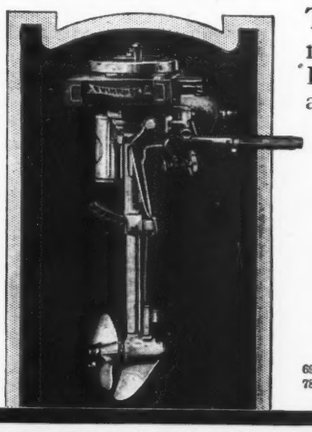


EVINRUDE OUTINGS No. 2
Distant fishing grounds are easily reached when your row-boat or canoe is Evinrude powered.

Fishin' De Luxe!

THERE'S a new joy to fishing—a new "e-fish-ency"—when *your* boat is Evinrude-powered. No long, tiresome row to take the edge off the day's sport. You reach the best fishing ground *early*, and you're fresh and fit when you get there. You've set up your tackle on the way.

With this sturdy little motor to do your oar-work, you can go from weed-bed to weed-bed until luck is with you, without a thought of your distance from camp or cottage.



The Evinrude is now made in two models, Standard and Lightweight. Both motors are the same in design, power and speed. The Lightweight is more portable—due to judicious use of aluminum, it weighs just 50 pounds complete.

See these Evinrude motors at your sporting goods or hardware dealer's. Ask him about the Built-in flywheel Magneto, Tilt-up Attachment and other Evinrude features. Or write for catalog and new prices (recently cut to pre-war level).

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Monday—March 20

"Warm day. Got the bike out for Spring overhalling. One flat tire. Found little punctur. Fixed that alwrite by geting tube of Neverleak Tire Fluid down to Henry's Bike Shop. Squeezed it into tire and blew her up. Holds air like new. Cost 25c (for the Neverleak)."

Wednesday—March 22

"After school, rode over to see Fred's wireless set. Must of rode over some glass because I herd back tire go s-s-s-s-s and stop. That was the tire with Neverleak in and it stoped the leak while I was rideing."

Jimmy

NEVERLEAK

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"HEALS PUNCTURES ON THE RUN."

THE HOME WORKSHOP

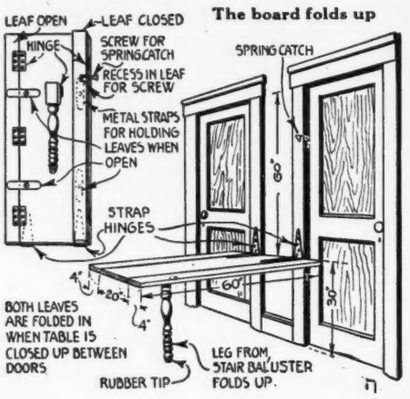
Folding Pullman Breakfast Board Saves Housewife's Steps

By J. W. Gilbert

(Second "Best Idea" Prize for May)

TO save steps in serving the breakfast, I designed a Pullman board for the kitchen, as shown in the accompanying illustration. In our house it is necessary to pass through the butler's pantry to reach the dining-room from the kitchen; therefore the table is a distinct advantage.

The kitchen is so small that it was difficult to find space even for this table. The



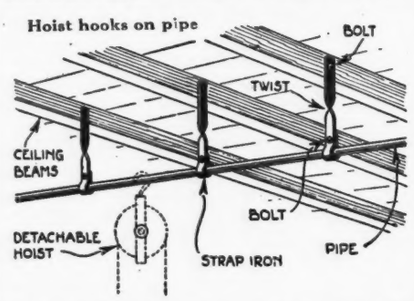
board was made, however, to fold up against the wall in a space of 20 in. between two doors. The dimensions can be varied.

For my purpose the material necessary was a board ⅞ by 20 by 60 in. for the top and two boards ⅞ by 4 by 60 in. for the leaves. A stair baluster served for the leg. When the table is down, the drop leaves are held in place by metal buttons fastened with screws to the large board.

It is well to plan the table so that it will be about 30 in. high. Place a rubber tip on the end of the leg to prevent its slipping. The table may be painted white or gray, and folding chairs may be used with it, if desired. It is large enough for four persons and will even accommodate five in an emergency.

Hoist Hangers Speed Up Work

TO support a portable chain hoist in an automobile repair-shop, attach a pipe within reaching distance from the shop floor with iron straps. These should be bolted



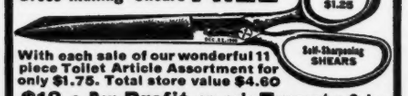
to the ceiling beams near the top so the beams will not be weakened. The pipe is secured by turning the iron straps over it. The support should extend across the shop in the most convenient position.—J. W.

POINTS of scribers and other small tools are easily hardened by heating them to a cherry red and plunging them into a can of soft soap.

YOU CAN MAKE $18 DAILY PROFIT

With Our Great Introductory Offer

Giving These $1.25 Dress-Making Shears FREE VALUE $1.25



With each sale of our wonderful 11 piece Toilet Article Assortment for only $1.75. Total store value $4.60

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Act Now! Sell like hot cakes year 'round. A baby could sell Lucky 11. Don't wait a minute. Save time. Send $1.75 for complete outfit including display case. At least write for circulars explaining our unique plans, including 30 other packages. **ACT NOW!**

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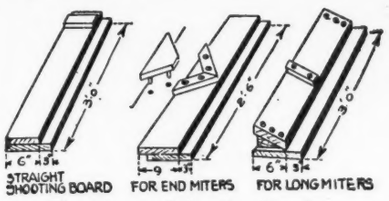
THE HOME WORKSHOP

Add a Shooting Board to Your Shop Equipment

MANY home workers who are interested in cabinetmaking do not fully appreciate the value of a shooting board as an aid in planing edges square and true. Various types of bench blocks, such as the one described on page 92 of the December POPULAR SCIENCE MONTHLY, serve as shooting boards for small pieces or for end planing, but a real shootboard, as it is sometimes called, is longer and heavier.

Three sketches are given, one of a plain shooting board, another of a miter shooting



Three types of shooting boards

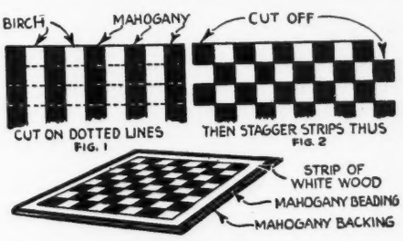
board for trimming the joints of mitered frames and the like, and a third for miter joining the long edges of boards. In each case the plane slides on its side at the right while the stock is held firmly on the left half of the board.

The stops on the miter shooting board may be screwed on permanently or formed by a single removable piece of triangular shape, held accurately in position by three tight-fitting dowels. The second arrangement permits the board to be used both for straight and miter "shooting" if an end stop is screwed on as in the straight board.

As soon as you have made a shooting board, you will be anxious to use it. One of the neatest and most interesting little problems it will assist you in working out is a chess and checkers board.

Cut and plane up on the board five lengths of ⅛-in. walnut or mahogany exactly 1½ in. wide and about 13 in. long. Do the same with four lengths of birch or some hard white wood. Glue them together as shown in Fig. 1, forming a board ⅛ by 13 by 13½ in.

When dry, cut across the original strips, forming eight new strips made of nine 1½-

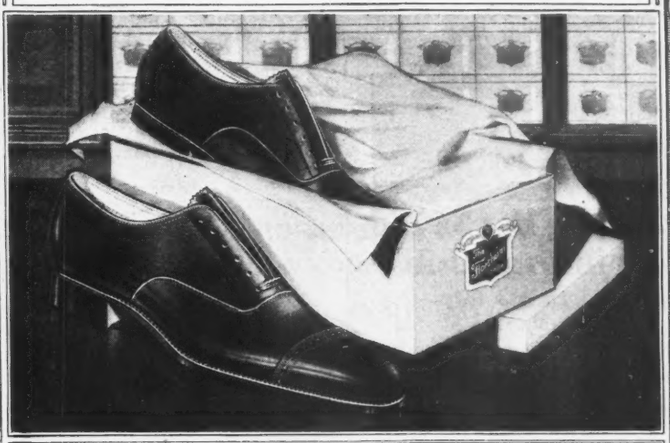


How a checkers board is made

in. squares, the final size of each strip after planing on the shooting-board being 1½ by 13½ in. Now glue together as shown in Fig. 2, and when dry cut off the projecting walnut pieces, leaving a 12-in. square containing sixty-four 1½-in. squares.

This may now be inlaid in a table, then planed and polished. If a separate board is desired, glue on 2-in. strips of light color mitered at the corners to serve as a margin. A piece of ⅜-in. mahogany should be glued over all the back and a ¼-in. beading of mahogany around the edges. Screw another piece of ⅜-in. mahogany across the back with its grain at right angles to that of the back piece to prevent warping.—A. W.

THE FLORSHEIM SHOE



The Ormond—Style M-92

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—and paved the way for a better one!

IT was written to his employer by the International Correspondence Schools. It told how "Robert Johnson had enrolled for a course of home-study and had received a mark of 94 for his first lesson."

Bob answered the summons to the Chief's office with just a little fear and trembling, for a lot of men were being dropped—a lot more were having their pay reduced.

But as Bob came in, his employer did a surprising thing. He got up quickly from his desk and grasped Bob warmly by the hand.

"I want to congratulate you, young man, on the marks you are making with the I. C. S. I am glad to see that you are training yourself not only for your present job but for the job ahead.

"We're cutting the pay-roll. Until I received this letter, I had you in mind as one of the men to be dropped. But not now. Keep on studying—keep your eyes open—and pretty soon there'll be a still better job for you around here. We're always looking for trained men."

Won't you let the I. C. S. help you, too? Won't you trade a few hours of your spare time for a good job, a good salary and the comforts that go with it? Then mark the work you like best on the coupon below and mail it to Scranton today. That doesn't obligate you in the least, but it will be your first big step towards success. *Do it now!*

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LOCKTITE opens easily or closes tight at pull of tip across top of pouch. No buttons or strings. Made from soft leathers; durably lined. Sold at cigar, drug, department and leather goods stores. If dealer cannot supply send $1.25 for most popular size.

Genuine Suede Rubber Lined.

Made and Fully Guaranteed by
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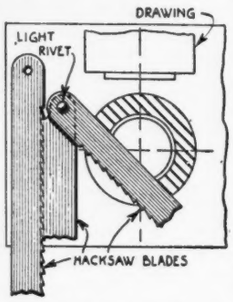
THE HOME WORKSHOP

Adjustable Section Liner Made from Broken Hacksaw Blade

A BROKEN hacksaw blade can be made into a very practical substitute for a draftsman's section liner as illustrated. The set of the teeth should be removed on a stone to eliminate any danger of scratching the paper. The adjustment of the sliding piece can be set at any convenient angle. By dropping down the adjustable piece as the part is cross sectioned, the lines can be drawn evenly and regularly.



Insures even spacing

This improvised instrument will enrich the shop drawing outfit and is rugged enough to withstand hard usage.—FRANK W. BENTLEY, JR.

Pedal Turns On Spring Faucet

TO make it easier to wash the hands in running water in a basin where spring faucets are used, it is a simple matter to arrange a pedal for turning on the water. Since only about a quarter turn is required to open the faucet, the cord may be attached to one of the sprockets of the handle, run over the side of the wash-basin and fixed to one end of a small board, ⅞ by 2½ by 12 in. When the cord is attached, the board should be about 1 in. from the floor at one end while the other end may be held in place by screwing screweyes into the floor on each side and driving nails through them into the sides of the board.

Leaves the hands free

This contrivance allows the water to be turned on merely by the pressure of the foot on the pedal and obviates the necessity for closing the stopper and holding the faucet open with the hand while the bowl is filling. The hands and face can be washed with running water without touching the handles of the faucet.—DR. A. F. KOCH.

Rattail File Serves as Reamer

A GOOD substitute for a reamer is a rattail or round file used in an ordinary brace but turned backward instead of forward. It will cut a perfectly smooth, round hole, and do it quickly. If the hole is small, a common file handle will serve instead of the brace.

The utility of the file is self evident in cases where a hole has to be enlarged in a tempered steel plate, such as a saw-blade. A reamer would be damaged, but the file, if properly used, will receive little or no harm. The secret of success lies in turning the brace backward.—J. H. LUNDY.

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and sparkling beauty with the penetrating, stimulating violet ray. Pure blood, a clear skin, calm, steady nerves can be yours. No shock or unpleasant sensation — just the healing warmth and stimulation of

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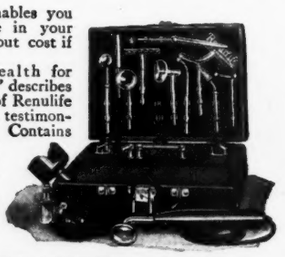

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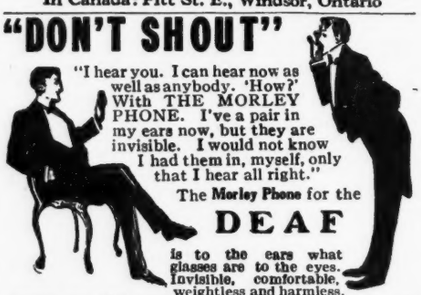

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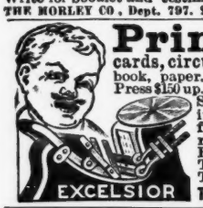

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THE HOME WORKSHOP

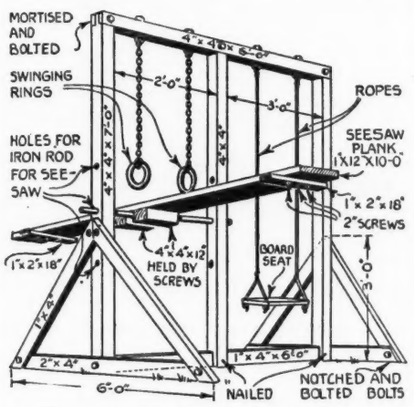
Outdoor Gymnasium Provides Healthful Sport for Children

By A. W. Roe

DESIGNED especially for small children, the gymnastic apparatus that is illustrated has the good features of being easily built by the home mechanic at low cost, of being removable from one place to another, and of furnishing the means by which children may enjoy themselves in vigorous, beneficial exercise in the open air. The gymnasium provides swinging rings, a stationary bar for trapeze and other work, a seesaw and a swing.

For the uprights use 4 by 4 in. posts 7 ft. long. They are held together at the top by a runner 6 ft. long, which is mortised and bolted to the uprights. A board 1 in. by 4 in. by 6 ft. nailed across the bottom of the uprights holds them steady.

Bore four holes in the top runner for U-bolts to support the rings and the swing. Next, build an end support on each outside



The apparatus may be taken apart for shipment

upright, as shown. These supports are sufficiently broad to keep the apparatus from toppling over, but they should, nevertheless, be set on very firm ground; in fact, it would be best to bury the foundation about 4 in. for the double purpose of steadying the apparatus and getting the bottom pieces out of the way, so that a child will not be so apt to strike them in case of a tumble.

The seesaw is made of a sound plank, 1 in. by 12 in. by 10 ft. Two blocks prevent it from sliding off the rod. When it is desired to use the rings or horizontal bar, the seesaw may be lifted off.

The swing is supported by a good grade of sea-grass rope and is furnished with a board seat. The rings are hung on chains; they and the different bolts used may be obtained at any first-class hardware store.

To guard against decay, the lower parts of the apparatus should be creosoted, and the entire outfit should be painted. In moving the gymnasium, it may be knocked down and packed, or it may be loaded onto a track just as it stands.

Reversible Auto Engine Stand

A CONVENIENT engine stand can be made from two old automobile rims and two lengths of angle-iron. The best feature of the device, besides its cheapness, is that the engine can be rolled over so that the bearings may easily be reached.—H. F. B.

WANTED IDEAS

Inquiries from Manufacturers and Others Who Are Looking for Good Ideas

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are constantly being received. Manufacturers are always interested in any new device for which there is a market, which fills a long felt need, which makes production possible at a lower cost, or which will do the work BETTER. Extracts from some of the more recent letters received are printed herewith. There is undoubtedly a great demand to-day for really worth while inventions.

Can You Help?

Here are abstracts from a few recent requests I have received from those who wish to buy, finance or manufacture good inventions. Have you an idea that will fill the bill?

Following is an extract from letter dated July 20, 1921, from a middle western manufacturer whose volume of business last year was approximately $1,000,000. "If you are in touch with any meritorious proposition seeking manufacturing facilities, in the automotive or some other good field, we shall be glad to have you place us in touch with it. We are willing to consider outright purchase of patents or manufacture upon a royalty basis."

Another request from a large corporation, dated June 27, 1921, follows: "Should you have clients whose inventions are worthy of commercial manufacture and exploitation, we shall be glad to consider the financing of such projects, if they are interesting. In that event, we indicate also that we are identified with two large machinery manufacturing plants located, respectively, in Bridgeport, Ct., and Providence, R. I. These plants, besides having their own foundries, are thoroughly equipped to manufacture anything from a small lathe to a complete automobile. Whether your clients have mechanical inventions or otherwise, we shall be pleased to hear of any proposition requiring financing."

Another letter dated April 28, 1921, from a large corporation whose officers include some of the best known men of the country, says in part: "We are in the market for an invention of merit possessing undoubted economic and commercial value combined with ADEQUATE PATENT PROTECTION."

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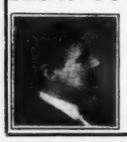

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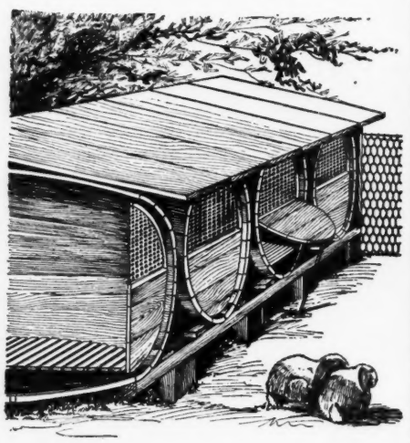
THE HOME WORKSHOP

Turn Barrels into Hutches for Rabbits and Belgian Hares

IN order to raise rabbits successfully, small space is required, but each animal should be provided with a separate hutch, and must receive plenty of light and fresh air. Barrels may be used for the pens if a number of them are obtained, placed side by side and covered with matched boards or tar paper so that the rain will run off. The open spaces between barrels and roof should be filled in tightly with excelsior, short straw, moss, or earth.

The interior of each barrel, after it has been thoroughly cleaned, should be washed



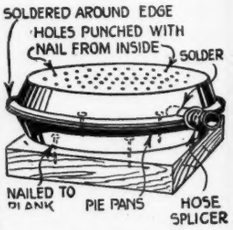
Dry, sanitary, and healthful rabbit hutches

with a disinfectant. The barrels are then placed on a low foundation, which should be at least ½ ft. above the ground and turned so that the bung is downward. To give the rabbits a dry floor, a network of slats is placed from one end of the barrel to the other. The front is closed with a door consisting of half a barrel top. The upper half of the front end is covered with wire mesh. Provide vessels for food and water.

A small run can be staked out around the barrels. The wire should be buried at least 2 ft. in the ground so that when the rabbits burrow, they will not escape under the fence. When these runs are placed in protected places, the animals can be kept in the open throughout the winter, but they should receive a generous quantity of straw for bedding. During the warm season the pens should be cleaned once a week; during the winter, once every two weeks.—E. BADE.

Using Pie Pans for Sprinkler

TWO pie pans can be pressed into service to make a useful if not ornamental lawn sprinkler. The pans should be fairly thick and substantial. They are soldered together around the rims after the lower pan has been nailed to a plank to form a substantial base. A hole is cut just large enough to be a tight fit for a hose splicer and a splicer is soldered on. Small holes are punched in the top of the sprinkler with a nail.—WILLIAM E. KING.



Costs little, but does the work

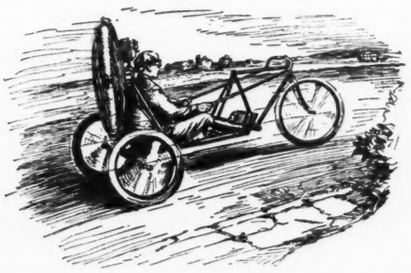
THE HOME WORKSHOP

This Practical Air-Driven Tricycle Costs Little to Build and Run

By Lawrence Hamilton

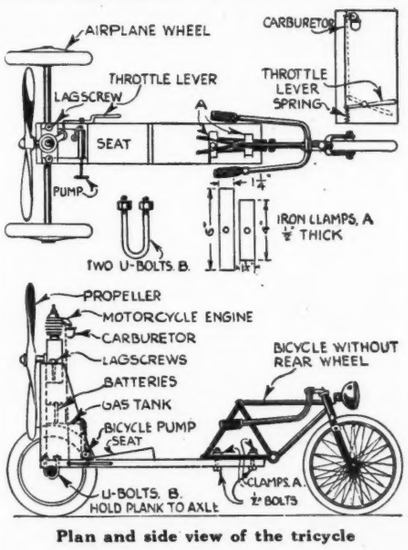
A ONE-CYLINDER motorcycle engine, a pair of small airplane wheels (or motorcycle wheels), an old bicycle, and a 2 in. by 12 in. by 10 ft. plank are the materials I used to make this air-driven tricycle. The motor and wheels were bought at a near-by motorcycle shop for $10.

A 5-ft. length of the plank was used for the floor of the machine. One end was



bolted to the rear axle and the other end clamped to the frame of the bicycle after rear wheel, seat, hanger, and chain were removed. The clamps were made as shown.

The motor mounting, placed directly over the rear axle, was made from the remainder of the plank. A piece 18 in. long formed the back of the mounting and the sides were two pieces 20 in. long, one side of each tapering from 12 in. at the bottom



Plan and side view of the tricycle

to 5 in. at the top. The front was covered with a large board hinged at the side. It gives access to the interior of the motor mounting containing the gasoline tank, batteries, and coil. When closed, this door forms the back of the seat.

As the gasoline tank is lower than the carburetor, air pressure is used to force up the gasoline. This is provided with an ordinary bicycle pump.

Lagscrews were passed through holes in the lugs of the motor into the motor mounting to hold it secure.

The only control is a throttle placed on the left side of the seat, arranged so that upon pressing it down the gas-valve opens, as shown in the diagram.

The propeller was made from a No. 1 white pine 2 by 4, carefully shaped and balanced. It was fastened on the crankshaft of the motor by means of locknuts and a pin through the propeller and shaft.

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THE HOME WORKSHOP

Drinking Fount for Birds Is An Attractive Garden Ornament

IN my yard, near a shade-tree, I have erected a drinking fountain for birds that is both useful and ornamental.

First I tapped the water supply in my basement, and, after attaching a cut-out drain, I laid a ½-in. pipe to the point where I intended to build the fount, placing the pipe below the frost line. With an "ell" I brought the pipe line up to about 4½ ft. above the surface of the ground. I attached a regular faucet by means of another "ell" so that the faucet turns upward. Into it is screwed a fine spray nozzle.

Construction of Fount

The fount was built around this pipe. I used concrete and pebbles, although rocks or brick would have served as well. The two basins are about 30 in. in diameter, the one about 15 in. above the other, with a central support of concrete 5 in. in diameter. When the forms were being filled, chicken wire was embedded in the concrete to provide reenforcement. The three outer supports were built of ornamental shells.

When the spray is on, the top basin fills with water. The lower basin contains earth to support vines, and flags are planted around the pedestal underneath. The plants thrive in the ample moisture which drips over from the bowl. As a finishing touch, a ¼-in. iron rod supports a bronze spread-eagle above the basin. When it is desired to water the lawn, the hose is attached in place of the nozzle.—E. H. CRUZAN.

To Fill Storage Batteries

FOR filling storage batteries with distilled water, a quart bottle, fitted with a large rubber stopper, may be used. Two holes are cut in the stopper. One piece of glass tubing, such as is sold by druggists, is placed in the stopper so that it extends nearly to the bottom of the bottle, and serves as a vent. Another piece is bent and inserted to serve as the drain.

No distilled water is wasted

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THE HOME WORKSHOP

Providing an Interesting Problem in Artistic Metalwork

By J. B. Miller

WITH patience and a little skill, any one can make a matchbox and burned-match receptacle similar to the one shown in the accompanying photograph. The design may be varied to suit the individual taste, but the one shown has been carefully worked out and will be found satisfactory.

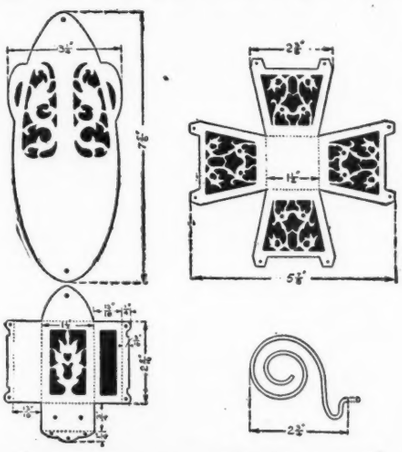
Utility and ornament combined

The matchbox and small hopper are made of 16-oz. sheet brass. Draw the pattern full size on paper as shown, and paste it on the brass. Drill holes through the parts that are to be sawed out and use a jeweler's piercing saw, or fretsaw for cutting out the design.

The box is fastened to the back with seven 3/32-in. rivets. Cut off each rivet so that it protrudes slightly through the hole, press its head against a piece of metal, and hammer down the end until a second head is formed, thereby holding the two pieces firmly together.

With a pair of pliers, the hook should be bent to the form shown, and the basket suspended from it by four small chains.

Further enrichment can be given the design by placing green crêpe paper behind



Lay out the patterns full size on paper and paste them on the sheet brass before starting work

the cut-out portions. Four pieces of mica or asbestos are then cut to fit the four inner sides of the basket. They hold the crêpe paper in place and prevent sparks from igniting it.

When the parts are polished and assembled, the matchbox makes an attractive and useful ornament for library or den.

Sawing Sheet Metal

SAWING a piece of sheet metal is easily effected if the metal is placed in the vise between two blocks of wood.—H. B.

Hear the Wireless Concerts at Home

from far and near. The latest news, market and weather reports now broadcasted by radio by our Government. Stations all about you

275 page No. 16 Radio Catalog—just out. "Send 25c in coin carefully wrapped for your copy of this wonderful book, the most unusual and complete catalog ever put between the pages of two covers. Not sent otherwise. It is not only a catalog, but a wonderful text book on radio. Enormous cost and tremendous demand prevents further distribution at a less retainer."

Ever since the year 1909

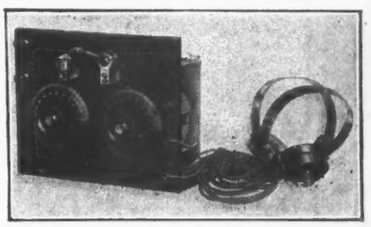
Duck's Radio Catalog

has blazed the way with everything worth-while and dependable in radio. This catalog eclipses all previous editions. It is all other catalogs in one. No other is even half as large. The complete catalog of the Radio Corporation, with a wealth of scientific data and diagrams, showing how to build powerful radio telephone transmitters, the Remler, Murdock, and in fact all other catalogs, are in this catalog. "Over fifty pages of the latest hook-ups (wiring diagrams), and invaluable and up-to-date data and information on radio, including important instructions for building antenna."

Radio Sets Cost Very Little

Complete sets sell for as little as $20—some even less. Today there are thousands bringing into their homes music, concerts and news hundreds of miles away, and with a loud speaker to replace the receivers on the ears, the entire family may clearly and distinctly enjoy the entertainment.

Type CV Crystal receiving set, $25.00. Beyond doubt the most advanced type of crystal set on the market for the clear and efficient reception of radio speech and music and telephone reception. Wave length range 700 meters.



We caution the public unfamiliar with radio to be careful about the cheap, inefficient and poorly constructed crystal sets that are beginning to flood the market. We are the oldest dealers in America selling everything complete in radio. Established 1908.

In tests with this set the radio telephone stations at Detroit (60 miles distant) was heard in Toledo with the greatest clearness and sweetness. Ideal set for persons residing within range of powerful radio stations in New York City, Springfield, Mass., Pittsburgh, Chicago and Detroit where wonderful concerts are broadcasted every evening.

Exclusive Features of these Sets

Tuning extremely selective. With type CV we use Duck's superselective Variometer and high class panel condenser. With type C we use Duck's superselective Vario-coupler and panel condenser. Each type has its adherents. Same type of tuner and condenser as on our $100.00 sets.

Another exclusive feature is the binding post for adding vacuum tube detector and amplifiers, thereby greatly increasing the range and avoiding discarding the set if these instruments are desired.

Grained formica panel 8 x 6½ x ¼". 3" dials. Crystal detector our best type. Murdock 2000 ohm receivers supplied as standard. Holtzer-Cabot $8.00 receivers $3.75 extra.

Complete instructions for setting up and operating. Any child can operate them. No battery or power necessary. Everything complete except antenna material.

Type CV crystal receiving set as described	$25.00
Type CV crystal receiving set as described, hinged cabinet type	30.00
Type C crystal receiving set as described	26.50
Type C crystal receiving set as described, hinged cabinet type	31.50
Renewal crystal mounted	.75
If Holtzer-Cabot $8.00 head sets desired add	3.75
Material for a 50 ft. 2 wire antenna	5.00
Material for a 50 ft. 4 wire antenna	6.00

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We want live responsible dealers in every city and town in the United States, both for the sale of our extensive line of radio apparatus and all other worth while lines of radio goods on all of which we can quote attractive discounts. We can offer you facilities and advantages that no other radio house can offer.

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While not classed as a musical star, Wallace Reid's Saxophone affords him much pleasure in home entertainment. His decision to purchase a Buescher was made after knowing it to be the

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Unrivaled for home entertainment, church, lodge or school. In big demand for orchestra dance music. A Saxophone will enable you to take an important part in the musical development of your community. It increases your popularity and your opportunities, as well as your pleasure.

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Instrument I play is.....

Edison Tells of Future Marvels of Radio and Science

(*Concluded from page* 22)

the time. With each generation we see more humanitarians in every country—more idealists. And notwithstanding our great commercial push, there are to-day more idealists in America than in any other country. But the increase at its best is slow.

"The thing most at fault, in a material way, today, is our method of interchange of commodities. Some people have too much and some too little, as a result of imperfections of our economic system. We need more even distribution. That is one reason why I endorse Henry Ford's water power idea so highly. The scientific and inventive progress with which your magazine and its readers are chiefly concerned have been yearly making Ford's vision more practicable. All of these things we have talked about—the automobile, the telephone, the motion-pictures, radio, the airplane—are breaking down forever the isolation of rural regions. The scientific progress to which we look ahead in the next few decades may complete this work. The city will no longer have a monopoly of the comforts and luxuries of life. The attraction of the farm may be again greater than that of the city, and we shall be drawn back to the soil in increasing numbers.

Henry Ford's Great Program

"And here is where Henry Ford's great idea plays its part. He sees the nation, far and wide, simply dotted with little centers of water power development. Wherever there is a stream, a waterfall, a rapid river, there will be a hydroelectric plant, surrounded by the health and beauty of the open country. Then fewer of us will live in the slums and soot of the city. More of us will be tilling the soil, raising crops, and earning money in between times in the local factories.

"Thus, first of all, the inventions of the past half century have been bringing to the country the conveniences and attractions of the city. Then, secondly, industrial organization, under a great humanitarian's project, may bring shops and factories back to the country, too, so that the division of interest between farmer and city dweller dwindles; those two great curses, unemployment in cities and unproductive seasons on farms, tend to vanish, and national solidarity to increase; because a greater proportion of our population falls into the same group—producers of wealth in the fields during part of the year, in the shops the rest.

"Ford's is a marvelous program. It is one of the greatest I have ever heard of. There is no vision of America's future, as affected by invention, past and possible, which I think more appropriate than this for discussion in the anniversary issue of POPULAR SCIENCE MONTHLY."

READING Mr. Edison's tribute, above, to Henry Ford's nation-wide water-power scheme, you will no doubt await with renewed interest the July Popular Science Monthly, in which Henry Ford himself writes an exclusive article upon the details of his project and describes his vision of a more prosperous future for us all.

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"SYLVIA" Diamond Ring
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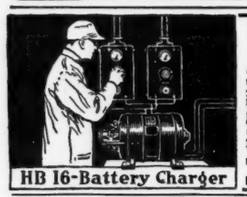

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$20 brings HB Battery Charger. Balance easy terms. $150 to $300 monthly profits. No repairs, no renewals, easy to operate. Sizes for 6, 10, 16 or 32 batteries. Let us recommend size for you. Free trial, money back guarantee. Write TODAY for information.
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You can sell RAZO, the new and novel Safety Blade Knife on sight. Just attach a Gillette blade and you have a practical article needed in every home and office. Send 25c. for sample and write for agent's proposition. Stamps or coin accepted.
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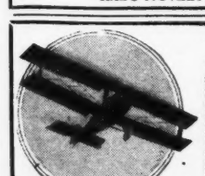

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Young man, learn aviation and prepare yourself for the future. Build your own plane and learn how to construct and fly aircraft. Use your motorcycle engine. We furnish very reasonable all the parts to build this wonderful little Metorplane. Easy to build and fly. Send $2.50 for the complete set of blue prints, and price list of all parts.
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This New Handy Time Saver Disc of screw threads and tap drill sizes will automatically give the correct size of any tap drill to be used when using any kind of a tap. The tap drill sizes for U. S. Standard screws; S. A. E. Standard for automobile work; tap drill sizes for all pipe taps also tap drill and body drill sizes for machine screws together with a complete table of decimal equivalents by sixty-fourths of an inch. Printed on the very best pressed fibre size 3 inches with printed instructions. 25 cents postpaid.
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is record of our stock car, using our special 1922 motor. Anybody can assemble this car. Send 30 cents for plans, instructions and price list of parts.
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THIS FREE catalogue tells you the kind of a Wireless Telephone to own, so that you receive inyour own home all the latest news, music, church services, lectures—everything broadcasted throughout the United States.

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Everyone interested in radio should see our low prices on parts and accessories. Write for this book. Learn about the miracle invention of the age. Easy to install, as simple to operate as a regular telephone.

One copy of this booklet is yours, free. Write for your copy.

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Only $45.00 For This Job Complete

Save exorbitant freight rates and one-half original cost by buying Ford Speedster Bodies knocked down. Simple, complete instructions furnished, all parts cut to exact fit. Any one can assemble this job.

Not Paper Patterns All Parts Complete

Complete with hood, radiator shell, instrument board, upholstering, metal parts, wood parts, bolt screws, etc. Flat radiator shell furnished made up. Designed low with lack of wind resistance. Price set up $90, further particulars on request.

The Central Auto Supply Co. Eng. Dept. 122 Louisville, Ky.

WHERE ARE MY TOOLS

Left around somewhere? Lost? Damaged? Stolen? Not if you keep them in a Union Tool Chest. It often saves its cost the first month by keeping your tools safe and in order. Write for booklet describing more than fifty styles and sizes.

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The Midget "Five-in-One" Slide Rule

is a combination Mannheim, Polymetric, Log-Log, Binary, Add and Subtract Slide Rule. It will instantly add, subtract, multiply and divide any combination of whole numbers, fractions, mixed numbers and decimals. Gives every root and power, also Logs, Sines and Tangents. Made of aluminum with scales on white celluloid. Size 4 in. Approved and adopted by colleges.

Price with Instructions, $1.50. Leatherette Case 50c. extra. Catalogue Free.

Gilson Slide Rule Co., Niles, Mich.

Agents: 90c an Hour

Introduce "Soderese." A new wonder. A pure solder in paste form. Works like magic. Stops all leaks. For mending water buckets, cooking utensils, milk pails, water tanks, tin roofs—everything including granite ware, agate ware, tin, iron, copper, zinc, etc.

Quick Sales—Nice Profit

Everybody buys. Housewive, mechanics, electricians, jewelers, plumbers, tourists, automobilists, etc. No leak too bad to repair. Just apply a little "Soderese," light a match and that's all. Put up in handy metal tubes. Carry quantity right with you. Write for sample and special proposition to agents.

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"Old Town Canoes"

"Old Towns" are patterned after real Indian models. They are the lightest, fastest and most durable canoes you can buy—and the lowest priced. An "Old Town Canoe" will float loaded in the shallowest stream. It will carry you wherever there's water. $54 up from dealer or factory. *New catalog shows all models in colors. Write for it NOW. Free!*

OLD TOWN CANOE CO.
1295 Main Street
Old Town Maine, U. S. A.

Perry Makes Radio Clear

(Continued from page 31)

the antenna circuit. They are exactly similar to the changes in the sound waves of your voice as you pronounce your words or sing your song. A radio expert can tell by measuring the current whether you were saying "ah" or "oh" when the measurements were taken.

In playing a flute you blow air into the instrument and sound comes out. By regulating the air you regulate the sound. In the radiotelephone transmitter you throw sound in and high-frequency alternating electric current comes out. Change the sound and you change the current. The trick is to carry the energy across hundreds of miles of space and turn it back into sound again.

The secret of the trick, as discovered by radio pioneers, is that an alternating current causes radio waves in the ether—that invisible substance that fills all space.

Every time the current moves and throws out its magnetic lines of force, it starts a wave in the ether, just as a bang on the side of a panful of water starts waves in the liquid. These waves, produced by the antenna current and the magnetic lines of force that it sets up around the wire, are radio waves. They spread in all directions, traveling with the speed of light. On being analyzed, the radio waves are found to be composed in part of magnetic lines of force similar to those that started them on their journey.

Your voice has started a lively little game of tag. Your transmitting antenna whams the ether and says: "Tag—you're it!" The ether waves chase a hundred miles or so, wallop somebody else's antenna, and say: "Tag—*you're* it!" The waves set up in that antenna an alternating current exactly similar to the one in your antenna. Distance and opposing forces make it weaker. Radio engineers say that the current set up in the receiving antenna is sometimes only three trillionths as strong as that which flowed in the transmitting antenna. But it is there and it can be changed back into sound. It can be amplified until you, speaking in tones far less powerful than those used by Mrs. Jones and Mrs. Brown in exchanging greetings across the busy street, bellow at an audience of 5000 persons assembled in an auditorium hundreds of miles away in accents that would have driven Goliath back to his tent.

If there are a thousand audiences of five thousand each, they all hear you just the same. Every little quaver of your voice, every little trick of speech, comes out of the receiver just as it went into the transmitter, though the actual sound of your voice does not carry beyond the walls of your room.

Having reached a receiving antenna and having been changed back from radio waves into alternating current, the energy is used in producing sounds. Weakened by its journey, it is not given hard work to do, but generally is used merely as a trigger for releasing stronger currents from local sources of power. It is passed through a transformer and by the process described before, its pressure, or voltage, is stepped up again.

Here once more the marvel of magnetism—the energy that cannot be worn out by use—is demonstrated. In one coil of the transformer the weak alternating current from the antenna builds up and collapses

(Continued on page 108)

Make This Test Yourself

Pick up a pair of Neverslip Pliers—moisten a piece of paper between your lips and fit it between the cutting blades. Then grip your hands. *Clip!* The paper is cut clean as a whistle.

And you can bet your bottom dollar that a plier that stands the paper test will cut anything from a ten penny nail to the softest wire.

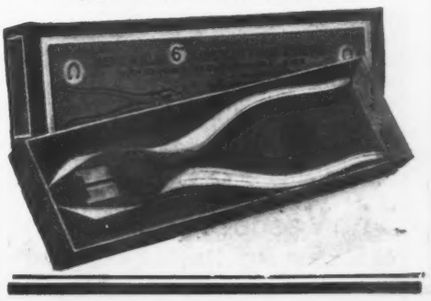
Neverslip Pliers cut clean because their cutting blades are made from high carbon crucible steel. But should the blades become accidentally damaged, they may be quickly and easily replaced—just like a safety razor. Neverslip blades are renewable and the plier will last forever. That's why Neverslips are guaranteed to outcut and outlast any plier made.

NEVERSLIP
side cutting pliers

Ask your hardware dealer to show you a pair of Neverslip Pliers. If he hasn't them in stock, send us his name and we'll see that you are supplied.

THE NEVERSLIP WORKS
New Brunswick, New Jersey

Neverslip pliers are furnished in 6-7 and 8 inch sizes



Is Your Machine Running Blind?

The only *eye* you can ever give your machine is—a counter.

Shouldn't it see that it gets fair treatment from its operator? Then it should have a counter.

Shouldn't it check up its own mechanical competence—as shown in production? That can only be visualized through a counter.

Watch production climb at the *best* of machines, when watched *automatically* with a

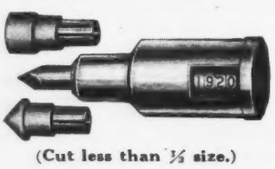
Veeder COUNTER

The Set-Back Rotary Ratchet Counter below is for machines such as punch presses and metal-stamping machines, where a *reciprocating* movement indicates an operation.

Registers one for each throw of the lever, and sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price with four figures, as illustrated, $11.50—subject to discount. (*Cut less than ½ size.*) Set-Back *Revolution* Counter of similar model, $10.00 (list).

Speed Counter

Here's the handiest instrument for finding revolutions-per-minute of a shaft or flywheel. You hold the tip of the counter against end of revolving shaft; press lightly when the second hand of your watch comes to O; release pressure when minute is up. A spring clutch controls the recording mechanism.



(Cut less than ⅓ size.)

The Veeder Speed Counter enables you to keep motors, engines, generators, line shafting and machines operating at **efficient speeds.** Price, with two rubber tips (as illustrated) $3.50.

Send for free booklet no matter what you want to count—automatically or by hand.

The Veeder Mfg. Co.,
44 Sargeant St., Hartford, Conn.

Perry Makes Radio Clear

(*Continued from page 107*)

its magnetic fields. In the other coil these fields induce another current of higher voltage. This is led, in the best types of receivers, through a vacuum tube, an electric bulb that is the heart of the modern radio sets. The current rises and falls as your voice at the transmitter rises and falls. It acts upon other currents that are passing through the vacuum tube, impressing the characteristics of your voice upon them. When these currents come out of the tube, they are direct, or one-way, currents. The tube (or the crystal detector, if that is used in place of the vacuum tube) acts like the valve of a pump. It lets the current pass in one direction, but prevents its going in the other direction.

Then the wire circuits lead the current to the telephone head set. On the way, the current may pass through other vacuum tubes which, with other transformers and some auxiliaries, form amplifiers. Each of these amplifiers may mulitply the effect of the current a hundred times.

Sometimes a "loud speaker" is used instead of the head phones. That cuts off all possibility of anybody in the vicinity escaping from the sound of your voice. Ye gods! what the stump speakers of the near future are going to do to us!

In the receiving telephone or loud speaker the electric current, which is now a one-way current coming in spurts, passes through the windings of an electromagnet similar to the one that zizzes your doorbell. The magnet pulls at the diaphragm and it shimmies exactly in time with the diaphragm of your transmitter. In the air it stirs up sound waves exactly similar to those that proceed from your voice box. With a perfectly designed outfit the sounds of your voice could be reproduced so exactly that your best friend would not know the difference.

There are often many inductance coils, condensers, and what not in the receiving set. That accounts for the number of knobs and switches on the front of your cabinet. These knobs are turned for the purpose of "tuning" your receiver to the distant transmitter.

Every transmitter, when in operation, sends out waves of a definite length. They can be measured and charted. Every receiver, if it is to deliver to the listener the loudest sounds possible to produce with the energy received from the transmitter, must be tuned to the transmitter. If the transmitter is sending out radio waves that are 360 meters long from crest to crest, the receiving apparatus must be adjusted so that it will just fit that length of wave.

Roughly speaking, the length of the transmitted wave depends upon the length of wire in the transmitter's antenna circuit. This is because the antenna starts out one wave each time its current swells out its lines of force around the wire. The shorter the wire, the shorter the distance the current has to travel around the circuit, the oftener it will change direction and swell out its lines of force, and the shorter the waves will be. Make a "buzz saw" out of a big button and a piece of string and the action of the string will help you to visualize what happens in the antenna. The shorter the string, the quicker the action.

To pick up 360-meter waves and get the most out of them, the receiver circuit must

(*Concluded on page 109*)

ASBESTOS

We are miners and shippers of Crude Asbestos in any quantity. We produce all grades at our world famous **BELL ASBESTOS MINES,** in Canada. We also card fibres, spin yarns, weave cloths and make all sorts of Asbestos products.

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An auto owner in each locality to use and introduce Mellinger Extra-Ply and Cord Tires. Make big money part or full time. No capital or experience needed. Sample Sections Furnished. GUARANTEED **8,000 & 10,000 Miles** (No Seconds). Hand made. Finest materials. Shipped prepaid on approval.

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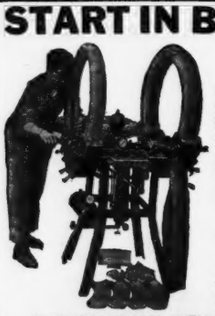

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Manufacturers of Modern Tire Repair Equipment,
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Perry Makes Radio Clear

(Concluded from page 108)

have the same length of wire, or its equivalent, as the antenna circuit that sent out the waves. In practice, "inductances," "condensers," and other devices are used to produce effects similar to adding wire to the circuit or taking wire out of it, for it is easier to turn knobs than it is to cut and splice wires.

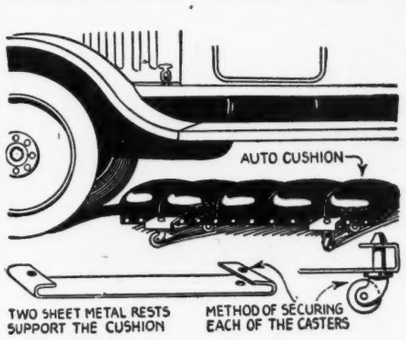
Musically minded persons sometimes think of the turning of the receiver knobs as they do the turning of the pegs of the violin to tune the strings to the pitch of the piano. This impression is strengthened when the turning of the knobs brings in station after station sending out music, just as running the finger down the violin string vibrated by a bow brings out one note after another.

The mineral detector type of radio receiver produces sound without the aid of any electric current except what it receives from the transmitter. That is even more wonderful from one point of view than what happens in the vacuum tube. The tube, with a storage battery furnishing electricity to light its filament, and a dry battery supplying current to its plate, ought to deliver results, and it does. Just how efficient it is was demonstrated when American amateurs, using about as much power as is required to light the lamp by which you read this article, were heard by operators in far-off Scotland, who picked up infinitesimally small amounts of energy from the transmitting stations, amplified them and produced sounds that could be heard and interpreted in spite of the rain and the gales of wind that whistled around their tent.

But the mineral detector type of receiver which makes a much shallower nick in our bankrolls, is not to be despised. Within five or 10 miles of a good radiotelephone transmitter, and often at greater distances, it will deliver a concert, lecture, or sermon to several listeners very satisfactorily and it requires little or no expense for upkeep.

Auto Seat Cushion Mounted on Casters Is Comfortable "Creeper"

THE wooden slat "creeper" commonly found in garages is not the most comfortable device for the repairman who is working under a car. A better creeper can



The garage man will find this an improvement over the usual creeper

be made by mounting a seat cushion on two supports that rest on casters.

The cushion, which can be an old and discarded one, not only makes a comfortable and convenient rest, but by its thickness it protects the workman from the cold and dampness of the cement floor.—L .A.

Your Foreman Knows—

When Your Foreman Sees You Using Brown & Sharpe Tools, He Appreciates Your Choice of the Tools of Master Craftsmen.

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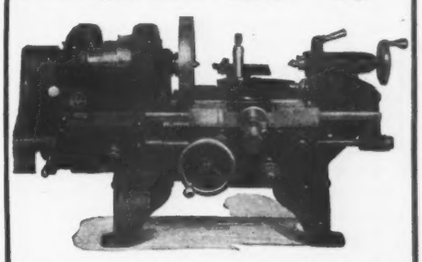

It is easy to learn to operate the MONARCH JUNIOR and even beginners can't jam it. It is equipped in every detail same as the big MONARCH and is guaranteed to do all small work that any other lathe will do.

You can find room for a MONARCH JUNIOR practically anywhere in a small shop or work-room in your home. Write today for catalog and full information about this remarkable—low priced engine lathe.

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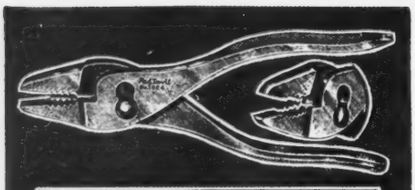

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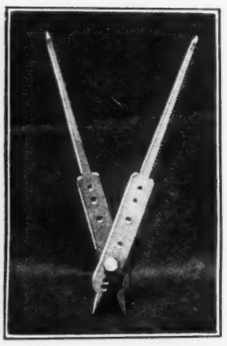
"Red Devil" Glass Cutters—the glaziers' standard tools of the world. "It's all in the wheel." Made in 40 styles. No. 024 shown below. 20c

THE HOME WORKSHOP

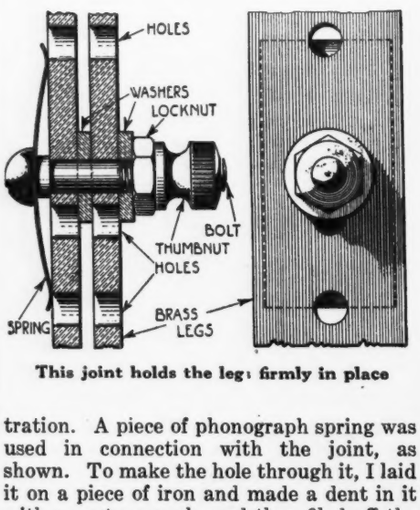
Accurate Proportional Dividers Made from Strips of Brass

HAVING frequent need for a pair of proportional dividers, I decided to try to make them for myself. I obtained two pieces of brass 3/16 by 1 in. and 12 in. long, although I later discovered that ⅛ in. by ¾ in. would have been better, as my dividers are really heavier than necessary. I clamped the two pieces together and drilled a series of 3/16-in. holes for the bolt. The spacing for the holes was as follows, measuring from the enlarging end of the dividers: For the proportion of 1 to 1¼, 6.666 in.; for 1 to 1½, 7.2 in.; for 1 to 1¾, 7.64 in.; for 1 to 2, 8 in.; for 1 to 2½, 8.572 in.; for 1 to 3, 9 in.; for 1 to 4, 9.6 in.; for 1 to 5, 10 in.; for 1 to 6, 10.287 in.; for 1 to 7, 10.5 in.



The dividers complete

After drilling the holes, I cut away part of the brass with a hacksaw and smoothed the points to the shape shown in the illustration. A piece of phonograph spring was used in connection with the joint, as shown. To make the hole through it, I laid it on a piece of iron and made a dent in it with a center punch, and then filed off the conically raised portion. I repeated this several times until the hole was large enough to enable me to put the end of a small rattail file in it and file it to the proper size.



This joint holds the legs firmly in place

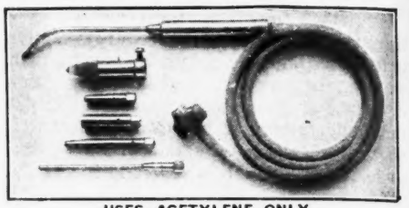
The bolt, locknut, and thumbscrew were taken from an old spark coil. Washers were placed between the legs and also under the locknut.—FRANCIS H. VAN HISE.

Improvised Pipe Wrench

OCCASIONALLY a pipe wrench is needed badly on a repair job and none is available. If an ordinary monkey wrench of suitable size and a coarse file are at hand, a substitute may be made by placing the file against one of the jaws of the wrench. Put the wrench and file on the work and tighten the jaws by hand as much as possible.

An old wrench, the jaws of which are not quite parallel, will serve better than a good wrench. It is surprising how well this makeshift pipe wrench will work.—F. L. S.

TORIT ACETYLENE TORCH No. 13
For radiator repairing, general soldering, light brazing, heating, battery repairing, etc. Produces instant hot flame, works rapidly. Furnished with 4 different tips and soldering copper, enabling you to do a wider range of work.



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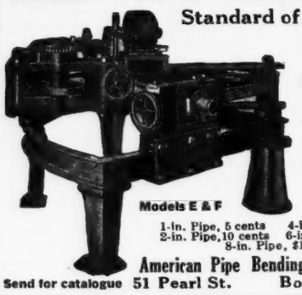

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Handles 4" and 5" grinding wheels; 6" saws; 6" and 8" sand discs, and 3/8" chuck. Top easily removed. Mountable on separate base with motor. Extremely compact; highly serviceable; decidedly practical. Not a toy. Height, 10". Weight, 31 lbs. Easily driven with 1-4 h.p. motor. Suited for Printers, Cabinet and Pattern Makers, Musical Inst. Mfrs., Furniture Repairmen, Shipping Depts., Manual Training Schools, Laboratories, Private Shops, etc. Machine fully guaranteed.
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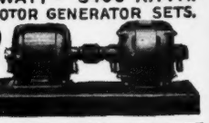

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Desk A, Erie, Pa.

THE HOME WORKSHOP

Tap and Drill-Hole Gage Made from Discarded Nailset

THIS little gage can be made from a nailset that has been discarded because of a worn point, although it is valuable enough to sacrifice a new nailset in order to make it.

Every mechanic is well acquainted with the difficulty of ascertaining the drill size of an existing plain or tapped hole, particularly if it is too small to be calipered. In most instances it is necessary to try several drills before its size is determined, and that often entails putting each drill through a gage to find out what size it is.

This gage is instant, accurate, convenient to handle and carry, and costs only a little time. It is made by grinding and polishing a flat spot of even width along the tapered point and graduating it to correspond with the diameters represented at the various points. The divisions are found by inserting the point into a drill gage and marking the depth near the flat spot with a hard pencil.

When this has been done, the gage is ready to be etched. Heat beeswax until it becomes quite thin, and immerse the point

The figures are etched with acid

until it is warmed through. The graduations are scratched through the wax with a scratch-awl and the size is marked near each one. On the illustrated gage the numbers represent thirty-seconds. If the gage is intended especially for a tap gage, it can be marked to instantly show the size tap to use. For instance, a ¼ by 20 United States standard tap requires a 13/64-in. hole; therefore mark the gage at the 13/64-in. diameter and designate the mark by the number 8, this meaning 8/32 or ¼ in.

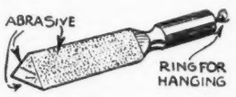
In scratching the graduations and numbers, do not strip the wax coating off other places. Scratching lightly will permit the etching fluid to do its work. This fluid is made of 1 part of nitric acid in 4 parts of water, only a few thimblefuls being required. The point is moved about in the acid for a minute or two.

As the graduations are below the general surface of the taper and never come in contact with metal, they do not wear and the gage therefore lasts a long time.

Intermediate sizes not shown can easily be computed, although it is also possible to divide each space between graduations by shorter marks.—HENRY SIMON.

Improving the Pencil-Sharpener

EXCELLENT pencil-sharpeners for draftsmen or other pencil users may quickly be made from abrasive powder such as is used for buffing. Prepare a block of convenient shape, either triangular or rectangular, coat the surfaces with hot glue, and apply the abrasive.



Glue and abrasives are used

Two or three different grades of the abrasive may be applied to the different surfaces, each marked with an identifying figure. The rough side can be used for rapidly shaping blunt pencil leads and the finer sides for finishing the points.—H. L.

Another New Starrett Tool —T-Handle Tap Wrench No. 93

An exceptionally handy tool. Although especially designed for holding taps to be turned by hand, it will be found exceedingly convenient for holding drills, reamers and many other small tools.

Special clamping construction insures firm holding of tool gripped. A centered body permits this wrench to be used on lathe centers or drilling machine to start the tap straight. Heat-treated jaws and clamping nuts guarantee durability.

You'll find this new No. 93 T-Handle Tap Wrench—like all Starrett Tools—thoroughly practical, dependable and durable. It's a tool you will want to keep handy.

Ask your hardware man to show it to you, with other new Starrett Tools illustrated and described in our special Supplement to Starrett Catalog No. 22W. Write for a copy of this Supplement—and, if you haven't a copy of the Starrett Catalog No. 22W, ask for that too. Both free on request.

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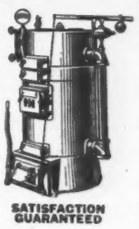

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"Tougher than Elephant hide" –because special 14½ ounce fabric

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Only the very best—the most carefully woven fabric—can stand such treatment without being injured. And Vitalics are not only built to withstand the shock, but to absorb it, so it does not reach the rider.

There are good sound reasons why the makers of such good bicycles as Black Beauty, Columbia, Dayton, Emblem, Excelsior, Indian, Iver-Johnson, Pierce and Yale use Vitalics on their better grade wheels.

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Bicycle Tires

THE HOME WORKSHOP

Developer Tubes Make Artistic and Decorative Flower Holders

By Ernest Bade

ORNAMENTAL flower holders for table decorations can be made from developer tubes. All that is required are strips of iron or brass about 1/32 in. thick and ¼ in. wide. With the aid of flat-nosed pliers the most pleasing designs can easily be turned out.

Draw the desired design on paper. Take a strip of the metal and, beginning at one end, bend it to conform to the drawing.

Single-tube holder

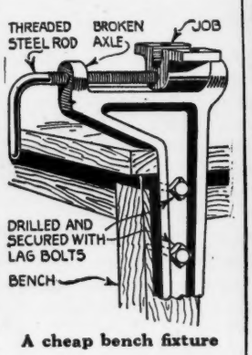
When three legs have been turned out exactly alike, two rings are made. They should be about ¼ in. larger in diameter than the glass tube. The rings are fastened together by means of U-shaped clips, which are firmly clinched in place. Three horizontal pieces as long as the tube are then made, the ends of each piece being bent backward and clinched to the rings. This will make the holder about ½ in. shorter than the tube. When this has been done, the legs are attached to the uprights and the holder is finished.

A twin-tube design

The same design need not be made twice. The appearance of the table is, indeed, improved if each tube has its own characteristic shape. A single tube is just as effective as two or three grouped in clusters, but variety increases the decorative effect.

Broken Front Axle of Automobile Forms Strong Vise

A SERVICEABLE vise for holding parts while doing repair work in the garage can be made from the end of an old broken front axle. Drill two holes so that the part can be bolted in an upright position on one of the bench legs. Tap one of the yoke ends for a clamp screw if the yoke is not already tapped, as is the case in some axles. A length of steel rod is threaded to suit the yoke and one end is bent to form a handle.



A cheap bench fixture

Wide parts that could not be placed in a small vise can be clamped in this one for drilling, filing, and the like.—A. G.

ART COLOR PRINTING CO., NEW YORK